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A MANUAL
OF
PATHOLOGICAL ANATOMY

BY
CARL ROKITANSKY, M.D.
CURATOR OF THE IMPERIAL PATHOLOGICAL MUSEUM, AND
PROFESSOR AT THE UNIVERSITY OF VIENNA, ETC.

IN FOUR VOLUMES

VOL. III.

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THE
PATHOLOGICAL ANATOMY
OF THE
BONES, CARTILAGES, MUSCLES, & SKIN,
OF
CELLULAR AND FIBROUS TISSUE,
SEROUS AND MUCOUS MEMBRANE,
AND OF THE
NERVOUS SYSTEM.

TRANSLATED FROM THE GERMAN
BY
CHARLES HEWITT MOORE,
SURGEON TO THE MIDDLESEX HOSPITAL;
LECTURER ON ANATOMY IN THE MIDDLESEX HOSPITAL SCHOOL OF MEDICINE.

EDITOR'S PREFACE

TO VOL. III.

A KNOWLEDGE of the value of Professor ROKITANSKY's personal instructions increases my estimation of the honour of being called to translate and edit a portion of his writings. I take this opportunity of acknowledging that honour, which has been conferred upon me by the Council of the Sydenham Society, as well as of expressing my thanks for their kind acquiescence in my wish to undertake those chapters principally which relate to the practice of Surgery.

The Preface to the Second Volume, by my friend Dr. SIEVEKING, leaves nothing for those who follow him to add, except, indeed, the testimony of time, that such a work as ROKITANSKY's 'Pathological Anatomy' becomes increasingly valuable to those by whom it is used. But the portion on 'Special Pathological Anatomy' must be used, as it was written, less as an elegant essay on Disease than as a register of well-observed—well-weighed—well-arranged facts. It is not adapted for the merely classical reader, but is a companion for the museum or pathological theatre,—a Lexicon, in which each case, as it occurs and needs explanation, may be found already at hand and in its place. It is, therefore, an invaluable book of reference for those who, amid the hurry of practice, require prompt and complete information. It should be observed, however, that facts take prominence in it according to their general pathological import. Rare facts, when isolated, too often occupy undue attention; by ROKITANSKY they are dismissed, perhaps in a few lines,—curtly explained, yet perfectly, because placed in their true relation to other facts.

The observation, that ROKITANSKY has not availed himself of the writings of all British pathologists, may not be without some truth. His work is, however, abundantly original, and cannot fail of being yet more highly estimated in this country the more it is known. Were there no other proof of this, it might be found in the needless labour that is still incurred by some English pathologists to arrive at facts and opinions which have been already ascertained, and already weighed, by ROKITANSKY. From his work, as from a fresh starting-point, such labourers may advance to new discoveries, without the risk of having priority claimed by a foreign observer.

I have made an effort, with difficulty indeed, to avoid the introduction of new scientific terms, and have therefore ventured to adopt a different title for the chapters from that which has been employed in the previous Volume. I have done so, however, with the less reluctance, as either mode of translating the original word "Abnormitäten" is perfectly intelligible, and as none of its general import appears to be lost, though divided between the two words "Anomalies and Diseases."

As to the other characters of the present Volume, a Translator has best fulfilled his duty, if he seem not to intervene between the Author and his readers.

In the descriptions of Microscopic appearances, I have mostly sought the judgment of my colleague, Mr. DE MORGAN. To him, and to my kinsman, Dr. MOORE, I am most happy to offer my grateful acknowledgment of their kind assistance in this, and not only in this, professional effort.

C. H. M.

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[Though the original of the line at p. 127, to which the foot-note refers, may be translated as in the text, its signification seems determined by a more complete description of apparently the same growths at p. 212, to be 'straight or convoluted elevations' of the surface, not exostoses separate from it.—Ed.]

PART IV.

ANOMALIES AND DISEASES OF CELLULAR TISSUE.

PART IV.

ANOMALIES AND DISEASES OF CELLULAR TISSUE.

§ 1. *Varieties in regard to quantity.*—THE cellular tissue contained in the human body is subject to variations in quantity which come within the sphere of Pathology.

In some bodies this tissue is overabundant, in others its quantity is smaller than usual; neither condition, however, constitutes more than an individual peculiarity.

But it may accumulate in excessive quantity in particular parts of the body, entering into the composition of various morbid growths and tumours, or forming an uniting medium between organs which in their natural state are separate from one another. As an areolar callus it may supply losses of substance which are otherwise irreparable, filling up cavities in the injured tissues; or it may become accumulated in excess, *i. e.* hypertrophied, at parts which have been subjected to continued irritation, as, for instance, in the neighbourhood of inflamed spots. And, lastly, it may occupy the place of parts which, in consequence of some fault in their original formation, are wanting; such as the bulb, the rectum, or the thoracic organs in cases of acephalus; the muscles, and even the bones, of incompletely developed limbs, &c.

Nevertheless, the presence of a mass of cellular tissue in the spot once occupied by some previously existing organ, cannot always be regarded as an exuberant growth of that tissue; for that which remains behind after organs have disappeared, whether from primary or secondary atrophy, or in the ordinary course of natural decay (Involution), is nothing more than the tissue which once formed the connecting medium in their anatomical composition, and which, therefore, then occupied the same place. This is the case with the thymus gland, and the mammæ, with absorbent glands, with the ovaries, &c.

Exhaustive diseases produce general diminution of the quantity of cellular tissue; and the same result ensues in particular portions of it, as well as in other organs, from continued pressure and from paralysis, and after suppuration and sloughing.

§ 2. *Anomalies in regard to Texture.*

1. *Hyperæmia, apoplexy of cellular tissue.*—Under suitable circumstances, particular portions of the entire system of cellular tissue are subjected to transient, or to permanent, congestions of an active, a passive, or a mechanical nature. These congestions, especially the two last-mentioned kinds, sometimes occasion spontaneous hemorrhages into the cellular tissue (apoplexia textus cellulosi); the effusions of blood are generally small and circumscribed, but sometimes they are large and more extended. The greater and more important extravasations occur in the lower extremities, in the sexual organ of the female, and in the abdomen. One of the most interesting cases of the kind was communicated to me by Professor Fischer of Prague: the blood was effused into the orbit, and it had coagulated in large firm tuberos masses which forced the eye forwards out of the orbit.

2. *Inflammation.*—Inflammation of cellular tissue (inflammatio telæ cellulosæ) is a disease of much importance, not only on account of the circumstances attending its occurrence in that tissue itself, but also because, as a consecutive and as an allied affection, it accompanies the inflammation of all structures which are imbedded in it. Thus inflammation of serous and fibrous membranes, of muscles, lymphatic glands, vessels, nerves, &c., is attended by inflammation of the cellular tissue that surrounds them. Its course is sometimes acute, sometimes chronic. *Acute* inflammation affects principally large tracts of cellular tissue, such as that beneath the integuments of the trunk and limbs, the cellular tissue accumulated in the neighbourhood of the cæcum and rectum, the deeper layers of the same structure in the neck, and that in the mediastina: and it is very often remarkable for its great extent, and for the devastations which it causes. Its anatomical characters are as follow:

The appearance of the cellular tissue varies according to the degree and the character of the inflammation and the condition

of the blood. It is swollen, injected, and of a bright or a deep red colour: it has in every case lost its extensile and elastic properties, and may be easily torn: among its fibres, and between its laminae, inflammatory products are effused, which differ in having more or less plastic qualities; and are, accordingly, either a viscid, and turbid or flocculent, serous fluid of a pale-red, or yellow, or grayish colour; a yellowish-red, gelatinous, and more consistent exudation; a brownish-red, fibrinous product, which fuses with the tissue into a hard, but yet fragile mass; or a dark-red (hemorrhagic), discoloured effusion. The inflammation always involves the adjoining organs, more especially membranous expansions, serous and fibrous membranes, and the integuments. The disease in this last instance is that known by the name of Pseudo-erysipelas.

The adipose tissue presents a similar kind of injection and reddening: when the inflammation is slight, it is percolated by a viscous, turbid, oleo-serous fluid, which gives the fat vesicles a pale, yellowish-red, translucent, jelly-like aspect. In inflammations of a severer character, the adipose tissue becomes brownish-red; the contents of the fat vesicles liquefy and escape through their walls, and a plastic exudation takes their place, and gives to the whole tissue a uniform granular appearance, and a certain degree of firmness.

Acute inflammation of cellular tissue, when moderate in degree, usually terminates in *resolution*, that is to say, by the complete reabsorption of the inflammatory products; merely some œdematous swelling, or a tendency to œdema remaining in the part which has been inflamed.

In other cases the inflammation leads to *induration* and *hypertrophy* of the tissue. The inflammatory product becomes organized, and the mass of the cellular tissue hypertrophied; and hence, as well as from the unnatural adhesion the new substance produces between the old strata of the tissue, the entire structure becomes denser, more compact, than natural, or as it is called *fibro-cellular*.

Inflammation, when it reaches a high degree, very often proceeds to *suppuration*. As the firmness of the inflammatory swelling subsides, a serous exhalation reappears in the tissue, the product of the inflammation becomes resolved into pus, and thus the cellular tissue in the centre of the inflamed spot,

and afterwards throughout it, is found infiltrated with a sero-purulent, and at length with a purulent, fluid. Yellowish or yellowish-red bodies which, though shreddy, are still somewhat compact and tough, are often found mixed with the matter: they are not sloughy cellular tissue, but the residue of the inflammatory product, and are therefore named *eiterpfropfe*—plugs of purulent matter—though, indeed, fibres of the cellular tissue are certainly interwoven amongst them, or even larger shreddy portions of it may adhere to them.

The points of matter, coalescing as the tissue is destroyed, unite into larger collections; and these extend further, either by forming sinuous canals, or by enlarging equally in all directions. If in the latter case, the matter be situated in the subcutaneous cellular tissue, it will separate the integuments to a great extent from the deeper structures, and will perforate muscles and aponeuroses, or open into serous cavities, into the intestines, &c.

Matter may also collect in cellular tissue from mere gravitation; for abscesses are met with, none of the contents of which, or at least but a part, have been produced by inflammation in the spot where they are found: the matter has gravitated thither from some part more or less remote.

In whichever way the abscess may have originated, it not unfrequently becomes encysted, that is to say, circumscribed by a cellulo-vascular granulating membrane. This membrane is the product of a secondary inflammatory process at the confines of the suppurating part, and itself secretes pus. It often remains for a long time in this state, and at length usually produces exhaustion by the continued secretion of matter from its walls. Occasionally, however, the formation of matter ceases, the walls become converted into a dense cellulo-fibrous tissue, and the matter is entirely reabsorbed, or part of it is absorbed and the rest inspissated. As these changes take place, the size gradually diminishes, until at length either its walls unite, or it is reduced to a cyst of trifling size, compared with its previous dimensions; the walls of such a cyst are thick, composed of obsolete callus, and encrusted on their interior; and its cavity is filled with a calcareous pulp or concretion.

Lastly, the product of the inflammation is sometimes of a peculiar nature, and leads to destruction and *sloughing* of the

cellular-tissue (to actual necrosis *textus cellulosi*). The tissue then breaks down, as it were, into a crumbling, or a shreddy, friable mass, and becomes infiltrated with a dirty brown or greenish sanies. Not unfrequently, under these circumstances, a quantity of gas is formed, which distends the whole of the diseased part.

Inflammation of cellular tissue may be a primary affection, or, as is very frequently the case, it may be secondary. Each form assumes a serious character in particular localities; as when it attacks the cellular tissue of the trunk or limbs; or that between the pericranium and the galea aponeurotica of the head; that near the submaxillary (Ludwig), or the thyroid glands; or that which accompanies the trachea, pharynx, and œsophagus down to the mediastinum; or the tissue upon the lumbar vertebræ, or on the iliacus muscle; or that in the neighbourhood of the cæcum (*perityphlitis*), or of the rectum (*periproctitis*), or bladder (*pericystitis*); as well as interstitial cellular strata, especially the submucous tissue of the stomach, intestinal canal, &c.

The inflammation, whether primary or secondary, may have a more or less distinctly marked exudative character; as is illustrated by *phlegmatia alba*, as it is called, amongst the primary inflammations, and by the numerous instances of inflammation which occur in cellular tissue by metastasis, after acute exanthemata, typhus, &c., amongst the secondary. They are often associated with exudative processes on membranous expansions, especially such as adjoin mucous and serous membranes.

Moreover, inflammation of cellular tissue is frequently derived from that of other parts. It uniformly accompanies the inflammation of structures which are imbedded in it; especially inflammation of veins, and lymphatic vessels, lymphatic glands, nerves, muscles, serous and fibrous membranes, &c. It is generally subordinate in degree to that which prevails in the actual seat of disease; though there are occasional exceptions to this rule, the inflammation in the neighbourhood of the actual seat of disease sometimes going on at isolated points to the more advanced degree, particularly to suppuration. Such is the case, for instance, in inflammation of veins.

Inflammation of the adipose tissue may subside, occasioning

merely some loss of the fat : in process of time, however, the loss is supplied again.

But in other cases, severe inflammation is followed by coalescence and obliteration of the fat vesicles, and consequently by a marked shrinking of the part which has been inflamed.

Inflammation of this kind often terminates in suppuration ; and the adipose tissue becomes converted into a yellowish-red pulpy mass, which is infiltrated with a fatty purulent fluid.

Lastly, a fibrinous inflammatory product is sometimes seen in the fat vesicles : it solidifies in them, changes into a cheesy mass, and in the end even becomes cretaceous. The wall of the vesicle is then found thickened, it contracts upon its contents, and bears traces of its previous congestion in the slate-gray or blackish-blue colour with which it is tinged. This change is principally observed on the fatty tissue of the omenta, and appendices epiploacæ ; especially in tubercular subjects, in whom peritoneal inflammations have occurred and have been attended with tubercular exudation.

Chronic inflammation of cellular tissue is distinguished by the following characters : the tissue is but slightly injected and reddened ; though where it is exposed, as it is at the base of ulcers, its colour is a deep red, tinged with various shades of brown, coppery, rusty yellow, violet, &c. : it is also denser than natural, and contains a viscid serous fluid, which when ulcers exist, filters through to their surface.

Inflammation of this kind does not proceed to suppuration, except perhaps at a few small isolated spots : it tends rather to induration, and that at an early period. The tissue is then very compact, and so tough that it makes a creaking noise when it is cut : it is also pervaded, and as it were identified, with a gelatinous matter, or an albuminous substance resembling lard. The tissue is found in these various conditions beneath and around chronic ulcers, in the neighbourhood of fistulæ, after repeated and habitual, or mismanaged attacks of erysipelas, or as a consequence of mechanical hyperæmia, or congestions arising from varicose veins in the lower limbs, in cases of elephantiasis, &c.

An inflammatory process of a peculiar kind occurs in newborn children, and is known by the name of induration of the

cellular tissue, (sclerosis telæ cellulossæ.) It occurs on the trunk, especially on the whole of the lower part of the abdomen, as well as on the thighs, and the cheeks. The subcutaneous fatty and cellular structures are moistened by a yellowish viscid serum, the fat is condensed, and forms a yellowish or brownish-red hard granular mass, and the skin covering it is tense, as firm and resisting as a board, glistening, and pale or of a yellowish-red colour. The numerous theories which have been broached as to the nature of this induration of cellular tissue and its etiological relation with disorders of internal organs are daily proved to be unsound. Thus it has been traced to diseases of the liver or lungs, to permanent patency of the fœtal canals and cyanosis, and to irritation of the stomach and intestinal canal. But these conditions, and even the icterus, which is its most frequent associate, are all accidental complications. The induration is unquestionably an independent disease, (occasioned by disorder of the functions of the skin of the new-born child,) and, just as in burns of the integuments, its seriousness and danger are directly proportioned to its extent.

3. *Depositions, metastases*, are very frequent both in the subcutaneous and in the deeper layers of cellular tissue. The deposits are of purulent and ichorous nature, and are often very numerous and extensive. They sometimes result from a primary and spontaneous pyæmia, which has been occasioned by pus or sanies having been taken into the mass of the blood; and sometimes from a state of the circulating fluid, in which other processes, exanthemata, typhus, &c., have led to the generation of pus by the blood in a secondary manner.

4. *Gangrene of cellular tissue*.—Mortification is liable to take place in cellular tissue, not only as a consequence of inflammation, but under other conditions also, as a primary disease. Sometimes the tissue, at first congested, and dark-red in colour, changes into a blackish, very moist, shreddy, and friable pulp: at other times, after having formed a blackish-red, viscid pulp, it becomes a dry, tinder-like, crumbling eschar. Lastly, it sometimes degenerates into a *white* mass, shaded with dirty yellow or greenish, and is moist and extremely easily torn.

5. *Adventitious growths*.—The adipose and cellular tissue beneath the skin, as well as that which is collected in larger

quantity in the internal regions of the body, is occasionally the seat of *cysts*. The contents of these growths are exceedingly various; sometimes being serous, sometimes resembling synovia, or gum (colloid), fatty, cholesteatomatous, or melanotic. *Fibrous tumours* occur in the same structures: *calcareous concretions* are very seldom met with, the only instances being that in which a fibrinous exudation in the fat vesicles becomes, as has been mentioned, converted into chalk, and that of cord-like growths, or smooth, or tuberos plates of bone, which occur in the fibroid callus of which the cicatrix of cellular tissue is composed. *Tuberculous* matter is deposited in young persons usually, and especially in children; the depositions occur in the subcutaneous tissue, and are more or less circumscribed: they soften and form a cheese-like or fatty pulp, and then exciting an inflammatory process in the integuments, which ends in ulceration, they make their way outwards. They are always associated with tuberculosis of the lymphatic glands, and frequently with the same disease in other parenchymatous organs.

Sarcomatous and *cancerous* growths are frequent in cellular tissue, and of the latter it is the genuine white medullary form, and the cancer melanodes that chiefly occur.

Among the *entozoa*, the *filaria medinensis* is met with in the subcutaneous cellular tissue.

§ 3. *Anomalies of Secretion, and Accumulations of Foreign Bodies in Cellular Tissue.*—In the first place, the fat is subject to considerable deviations from its natural quantity and quality.

Not unfrequently it is found collected in excessive amount, and at the expense of the nutrition of other structures, especially of the muscles. The excess, when uniform throughout the body, constitutes what is expressed by the general term obesity, and to it the female sex is particularly liable: but in some cases it accumulates at particular spots externally, and disfigures the body; or internally in such a manner as to narrow the space of the cavities of the body, and to interfere with the functions of the organs contained within them. Thus it collects at the lower part of the abdomen, on the nates, and on the loins, (in which region the rolls of fat are situated, which distinguish the race of Hottentot women;) it is found, too, in the neighbourhood and in the cellular interspaces between the

lobes of the mammae in women ; in the mediastina, and beneath the pleura ; in the folds of the peritoneum ; around, and in the duplicatures of, synovial membranes, &c. The local accumulations just mentioned, constitute a sort of transition to the fatty tumour, *lipoma*. Invested with a cellular sheath, lobulated by interstitial cellular tissue, more or less of which traverses its interior, and resembling adipose tissue in its intimate texture, the fatty tumour chiefly occurs in those regions at which fat is naturally most abundant : it is, however, sometimes found in parts where in the normal state no fat is deposited ; as, for instance, in the submucous cellular stratum of the intestinal tract.

Yet more frequently, in the emaciation which attends disease, the quantity of fat existing is found remarkably small, and at certain parts of the body, if not everywhere, it may even entirely disappear.

Moreover, the fat presents various qualitative deviations from its physical, and no doubt also from its chemical, properties. Sometimes it is remarkably pale, and sometimes, on the contrary, of a very dark colour ; it may be soft, gelatinous, suety, greasy, like the marrow of bones, and oily ; or again, firm, and resembling soap or adipocire. Thus in advanced age, and in persons whose muscular system loses energy and bulk, and becomes prematurely aged, the fat is of a deep yellow colour and oily ; in spirit drinkers, in persons who are negligent as to the state of their skin, in those whose skin is thick, soft, and dark coloured, or in whom the liver is suety, or the heart the seat of fatty metamorphosis, &c., it is usually pale, and resembles mutton suet.

In dropsical patients it is often reddish, firm, and granular, the fat vesicles shrinking together, and forming a reddish firm acinus : but otherwise it disappears, and after it has been absorbed, its place is occupied by a fatty, gelatinous, and, at last by a serous, fluid.

The serum, which in the natural state, is uniformly diffused through the cellular tissue and moistens it, is subject to similar deviations from the healthy condition.

It is almost entirely wanting in cases of considerable general or partial emaciation, in the marked collapse which succeeds convulsive diseases, or when, as in serous diarrhoeas and Asiatic

cholera, the serum of the blood is rapidly lost, &c. In these cases the cellular tissue is dry and crepitant, and resembles that of plants. In other instances, again, it exceeds the natural quantity: this excess, when general, constitutes leucophlegmatia, hydrops universalis, anasarca: when local it is named oedema. The fluid varies much in colour, consistence, and composition, according to the processes by which its accumulation has been effected, as well as according to the composition of the blood; being either thin and clear as water: or rather thick, and like jelly, from containing albumen; or yellow, in consequence of the presence of bile; red from the admixture of more or less blood with it, or turbid, milky, whey-like, and flocculent, from its containing fibrin or purulent matter.

Among the foreign bodies found in cellular tissue are:

- a. *Gas*, which may be either atmospheric air or some of the various animal gases—*windgeschwulst*, emphysema. Atmospheric air accumulates in cellular tissue in consequence of wounds in the circumference of the thorax, by which the pleura is opened; and more frequently it succeeds penetrating wounds of the lung, fractures of the ribs by which the costal pleura is torn and the lung injured, ruptures of the lung and pleura occasioned by crushing, mortification of the lung and superjacent pleura, ulcers which perforate the larynx and trachea, and laceration of one or more of the air cells of the lung, (from violent coughing, &c.) The emphysema is occasioned either immediately by the entrance of the atmospheric air at the wound of the chest, or by its escape from the air passages into the adjoining tissue, or into the cellular structure which intersects the lung itself—*emphysema pulmonum interlobulare*. When the bowel is perforated either by ulceration or sloughing, its gaseous contents pass out into the cellular tissue: in some cases of mortification gas is spontaneously evolved, and the skin over it swells up, and forms a doughy tumour. Lastly, there are a few cases in which, without any of the above-mentioned causes, gas accumulates in the subcutaneous tissue, and still more frequently in the interstitial, and especially the submucous, cellular tissue of the bowel: such cases result from acute disorganizations of the blood, and are found when there is no trace of cadaveric decomposition in the body. Permanent emphysemas of the same kind are well

known to occur in the living subject, in consequence of convulsive affections.

β . *Blood*; which may be extravasated in consequence of injuries of various structures, either from external or internal causes: the extravasation may be diffused through the tissue, or circumscribed, or even encysted. Purulent matter also may be effused; and, from penetrating wounds, or spontaneous ruptures, or perforating ulcers, of the urinary passages, &c., urine may be extravasated. Lastly,

γ . All kinds of foreign bodies may be thrust into cellular tissue through wounds of the integuments, or pass into it from the intestinal tube; they sometimes wander further in various directions, and sometimes they fix in the cellular tissue within a capsule of false membrane.

PART V.

ANOMALIES AND DISEASES OF SEROUS AND SYNOVIAL MEMBRANES IN GENERAL.

§ 1. *Deficiency and Excess of Development in the System of Serous Membranes.*—There are various kinds of primordial defect in serous membranes. They may be entirely wanting. Sometimes the organs they should enclose are wanting too; but if these exist, the deficiency of the membrane is supplied by some adjoining serous expansion. They may be but partially developed. This is the case when serous cavities are fissured, or when, in consequence of a partial defect in the wall of separation between two serous sacs, their cavities have an unnatural communication with one another. Thus the cavity of the pericardium is sometimes continuous with that of the pleuræ, the peritoneum with the latter, or with the tunica vaginalis of the testicle, bursæ communicate with the synovial cavities of joints, &c. Moreover, a deficiency in the development of a serous or synovial membrane may depend upon the absence of the organ usually contained within it; in which case, particular duplicatures of the membrane do not exist.

Wasting of a serous membrane, obliteration of its cavity, degeneration of it into cellular tissue (*Rückbildung*), and its destruction by suppuration, constitute instances of acquired defect.

Excess of development may present itself as a congenital anomaly. It then sometimes assumes the form of unusual saccular prolongations and duplicatures of the membrane, or of folds which, though such as usually exist, are preternaturally developed,—a form of excess which may partly be traced to an arrest of development: sometimes appearing under another form, as a serous cyst, or an aggregation of serous cysts, or as a honeycombed serous tissue, it marks the site of some origi-

nally defective part, or of an organ which had been diseased and destroyed during foetal life,—the brain, for instance, in hemicephalus, or the kidneys.

It more frequently happens, that new serous tissue is formed at some period subsequent to birth; it may present the characters of true serous membrane, or may be cellulo-serous or fibro-serous. Thus,—

a. Bursæ, which are the simplest form of the synovial system, are developed beneath the skin, where it is exposed to unusual and permanent pressure and friction, as is the case in clubfoot (Béclard), over the point of an angular curvature of the spine (Brodie), or on the stump of an amputated limb: and they are also observed in deeper parts, between muscles and tendons, as well as between them and unusual protuberances of bone, &c. Moreover, dislocated bones are sometimes firmly fixed by a new synovial capsule; and the preternatural joints formed in cases of ununited fracture, furnish another example of the same new growth.

β. Membranous capsules are sometimes formed around foreign bodies, or around effusions of blood either in cellular tissue, or in various parenchymatous structures.

γ. Cicatrices upon mucous surfaces, the lining membrane of abscesses, and the material by which they are finally consolidated and closed, are composed of plates or of capsules of serous tissue.

δ. Acquired excess of development includes further the change of texture, and simultaneous alteration of secreting power to which, in some few instances, the skin is liable when excessively stretched; especially the skin covering broad expanses of tendon, (as, for instance, that on the abdomen.) The fact is observed more frequently under similar circumstances in mucous membranes, particularly in the excretory ducts and reservoirs of glands, when they become distended, and in the mucous membrane of the intestinal tube, especially in the appendix vermiformis.

ε. In like manner, the products of inflammation in serous membranes sometimes become organized into a cellulo-, or fibro-serous tissue, the characters of which, as to extent, intimate structure and firmness, vary considerably, and give rise to corresponding varieties in the adhesions which they produce between the parietal and visceral layers of the membrane.

ζ. The serous cysts, which are found in cellular, and in various parenchymatous, tissues, belong to the same class.

§ 2. *Deviations of Serous Sacs from their natural Size and Form.*—The principal deviations in these particulars are those in which serous sacs are enlarged; a change to which their great extensibility renders them extremely liable. In enlargements of this kind, the sac may be distended equally in all directions, and thus preserve its natural form; or being bound down in some situations by fibrous membranes, aponeuroses, muscular coverings, &c., it may yield at some other circumscribed spot, and give rise to a hernial protrusion or diverticulum, which communicates with the general cavity of the sac by a constricted neck.

§ 3. *Solutions of Continuity.*—Besides being exposed to wounds from fragments of bone and various instruments, serous membranes may burst or be torn by violent concussion and compression, and such rupture may be the only injury produced. Moreover, they are sometimes opened by primary and by secondary ulcerations, but that subject will be referred to again.

§ 4. *Diseases of Texture.*

1. *Congestion,—hemorrhage.*—Serous membranes are liable, under various circumstances, to an increased flow of blood into them, and to congestion: the cause may be active, passive, or mechanical; and the extent may be partial, or universal: the walls of hernial sacs, and the peritoneum covering the organs protruded into them, sometimes furnish an instance of partial congestion.

In proportion to their duration, or to the frequency of their recurrence, these congestions occasion more or less of a whey-like, or milky opacity, a loss of transparency, and at last thickening of the membrane. Such changes are sometimes general over the whole sac, and sometimes are confined to a portion of its visceral, or of its reflected, layer: they must be distinguished from organized exudations upon the free surface of the membrane. They give rise to the development of growths resembling cartilage or bone beneath the serous membrane, and are often accompanied by an increased secretion of serous fluid, which may be retained and so accumulate. The quality of the fluid varies with the character of the congestion and the con-

stitution of the blood; and may be pure serum, or may contain various coagulable matters, particularly albumen, or the colouring matter of the blood. Such cases constitute dropsies of serous membranes.

Congestion is sometimes so intense as to occasion hemorrhage into the sac; but this is a very rare occurrence in serous membranes generally, and can be called frequent only in the sac of the cerebral arachnoid. The bleeding in that case proceeds from the parenchyma, and is capillary; it must not be confounded with that which can be traced to the rupture of larger vessels, whether spontaneous or traumatic; or with that which originates with membranous or parenchymatous structures; or yet with hemorrhagic products of inflammation.

2. *Inflammation of serous membranes.*—This is one of the most frequent of all diseases: it befalls chiefly the larger sections of the system of serous and synovial membranes, such as the pleura and peritoneum; and the synovial membranes of large joints, like the knee and hip. It is sometimes a primary disease, and arises from disordered function of the skin, from mechanical injury, concussion, irritation, or contusion, or from contact with heterogeneous effusions, whether gaseous or fluid. Sometimes it is secondary: and then it is either sympathetic with, and induced by, disease of organs which are invested by the membrane, or contained in it, and is in fact merely an extension of the diseased process to the membrane; or it comes on from the metastasis of anomalous exanthematous processes, typhus, gout, and rheumatism; from absorption of pus and sanies into the blood, &c.; in short, as a consequence of any (secondary) morbid affections of the mass of the blood which are distinguished by a tendency to exudations.

It is very frequently an acute disease, but tolerably often, too, its course is lingering and chronic. In its acute form, and particularly when excited by metastasis, it often assumes an exudative character, which is very remarkable, considering the internal cause of the inflammation, viz., the general disease, or the local process itself.

a. *Acute inflammation.*—The anatomical characters of this disease are,—

a. *Redness and injection.*—These appearances commence with injection of the subserous tissue, which is seen through

the serous membrane; fine hair-like streaks of vessels soon extend here and there to the membrane, and when clustered together, give its internal surface an appearance similar to the pile of red velvet. At the same time, small quantities of blood (suffusions) escape from the vessels both of the membrane itself and of the cellular tissue beneath it, so that the surface looks speckled as well as red. The hue of the redness depends chiefly upon the duration of the congestion and the constitution of the blood, and varies from a bright to quite a dark colour. The extent and the intensity of the redness and injection also differ widely in different cases; sometimes they are partial and scarcely perceptible, sometimes they are universal and stain the membrane through. In many serous membranes, particularly those which, like synovial membranes, or still more the arachnoid, have a very delicate structure, the reddening which takes place is usually very slight, or there may be none whatever: these membranes admit of injection with blood only with much difficulty, and the degree of redness and injection is no criterion of the intensity of the process, so far as regards the quantity of product which the inflammation will supply; for the exudation, especially in inflammations of a croupy character, is remarkably disproportioned to the redness and injection of the membrane.

β. *Opacity and thickening.*—In those parts where the membrane is reddened and injected, and still more evidently in the interspaces between them, it becomes dull, loses its lustre, transparency, and smoothness, and acquires opacity and a velvety internal surface. Serous membranes of very delicate structure, such as the arachnoid, become at once opaque, dull, and turbid, like whey or milk. This change, and to some extent also the thickening, are due to infiltration of the membrane; but the thickening is produced rather by the simultaneous affection of the subserous cellular tissue; for that tissue is always injected, is early filled with an opaque serous fluid, and is consequently tumid. The infiltration of the subserous tissue extends to the membrane itself, and the two become so blended as to lose all trace of separation from one another. From the expansion, or loosening, of the tissues which takes place, the serous membrane is rendered not only very fragile in itself, but also easily separable from the structures beneath it.

7. The *effusion* or inflammatory product upon the free surface of the serous membrane is sometimes an exudation of plastic nature, but at other times, and especially in inflammations which arise from metastasis, it is diffuent and puriform, or actually purulent, or sanious. In quantity it is usually not very considerable, at least when compared with the amount of effusion attending chronic inflammation, though there are exceptions to this rule, especially in the case of exudations of a croupy character.

The plastic exudation is mostly accompanied by an effusion of serous fluid, so that the whole product may be distinguished into a plastic or coagulable portion, and another which is not coagulable. The relative quantity of the two portions varies considerably: there are some exudations which have no serous part whatever, while others contain no more of the plastic matter than suffices to render the serous effusion slightly opaque. An effusion of perfectly clear serous fluid, unaccompanied by any deposit of lymph upon the inner surface of the serous membrane, is scarcely such as can be attributed to actual inflammation.

The plastic portion of the exudation is deposited upon the inner surface of the serous membrane, and forms there a peripheral fibrinous layer which encloses the serous effusion, if any exist: it is of a grayish red, a yellow, or a grayish colour, and may vary in thickness from that of a scarcely perceptible film, like hoar frost, to that of several lines. Its inner free surface is sometimes tolerably smooth, sometimes villous, sometimes shreddy, sometimes areolar; occasionally it resembles waves of sand, or the back of a bullock's tongue. When the plastic matter is very abundant, it forms other large masses also of loose texture, and soaked through with more or less of the serum: it may also render the serum opaque, or may lie in it in flakes, which soon become arranged in plates and cords, and form a network or honeycombed cellular structure, the large interspaces of which enclose part of the serum. It may also fall upon the inner surface of the original peripheral coagulum, and form a soft shreddy covering for it; and in that case, the exudation lining the serous membrane consists of two layers:—the original, more consistent, plastic exudation; and the secondary, looser, shreddy precipitate upon it.

Inflammations of an eminently exudative character are particularly remarkable—

For the inconsiderable reddening and injection of the serous membrane :

For the disproportion which subsists between the reddening and injection, and the great quantity of exudation deposited at one time :

For the marked loosening of tissue, and infiltration observable both in the membrane and in the subserous structure :

For their frequently coexisting with exudative processes in mucous membranes, the plastic character of which may differ from that of the inflammation in the serous membrane :

And as a general rule also for the homogeneous nature of the whole product, and for the absence or mere indication of a separation of it into one part which is plastic, and another incapable of coagulation : it is an uniform exudation, which coagulates more or less, or degenerates into pus, or is sanious.

There is sufficient general connexion between the exudations under consideration and another found upon large serous membranes, like the peritoneum and pleuræ, to allow of the latter being mentioned here. It is a viscid coating upon these membranes which gives them a dull lustreless aspect : it is best marked and most constantly seen in cases of Asiatic cholera, but it occurs also in the course of other exudative processes which are attended by exhaustion, such, for instance, as the diarrhœa of children.

Plastic exudations very frequently produce adhesions between the walls of a serous cavity and the viscera it contains, as well as of the viscera with one another : but a large quantity of serous effusion holds the lamellæ of the plastic exudation apart, and no adhesion can take place unless the fluid be absorbed before the lymph is completely organized.

Absorption commences as soon as the lymph is deposited, and the intensity of the inflammation subsides : it depends, therefore, upon the cessation of the inflammatory process ; but it is also influenced by the thickness and density, that is to say by the permeability, as well as by the stage of organization, of the lymph.

In the organization of plastic exudations, new vessels are

spontaneously formed in more or less abundance, and a tissue is produced, which is either cellular, loose, and cellulo-serous; or of closer texture, strong, and, as it is called, cellulo-fibrous. If the serous surfaces have been agglutinated together by the exudation, their complete vital adhesion is effected by the formation of a loose filaceous, or of a dense and more compact tissue in the exudation: but in the opposite case, the old serous membrane is either covered with isolated delicate cellular flakes, or with larger shreddy masses of cellular tissue, or with a (second) delicate serous membrane, which can be moved over the original one, or lastly with a thicker, fibro-serous, and firmly attached layer. The layer last mentioned may be uniformly thick, or thinner here and there, and thus acquire a knitted areolar, or cribriform appearance: it may, with a little care, be stripped off the serous membrane, and when confined to small spots, it constitutes the tendinous or white spots (*maculae lacteae*) which are found on some serous membranes, especially on the pericardium.

In some cases, the solid exudation, as it becomes organized, encloses within it a part of the serous fluid, and thus forms delicate transparent vesicles, which are mostly found afterwards attached by a pedicle.

These new structures again may themselves be attacked by inflammation: this remark, however, is opposed by an observation made by Laennec upon the pleura; for he found, that inflammations of the portion of a serous membrane which had been left unaffected by a previous inflammation, were usually circumscribed by the new structures, and at the adhesions produced by them.

The puriform, the really purulent, and the sanious, exudations, are either deposited as such, or are formed out of the plastic exudation, which degenerates thus in consequence of some peculiar quality inherent in it. Such exudations are rather thick, cream-like, and yellow or greenish; or of a thin fluid consistence, and a greenish, brownish, or reddish colour: the serous membrane itself is discoloured; both it and the tissue beneath it are opaque and much infiltrated; and its inner surface is very dull, and appears, particularly when the exudation is purulent, like velvet or spongio-piline. If the inflammation does not destroy life, either of itself, or through the

general constitutional disorder which accompanies it, it usually becomes chronic.

b. Chronic inflammation.—Chronic inflammation presents itself in three different forms or kinds :

a. It commences as a latent, and continues as a lingering inflammation : though ordinarily moderate in its degree, from time to time it becomes more severe. It furnishes an exudation that is continually augmenting in quantity by gradual accumulation, and occasionally also by a more sudden increase. It sometimes affects several serous membranes at once ; but sometimes, especially if they should be near together, it attacks them one after another.

The redness of serous membranes, which inflame in this manner, is dull, and inclines to brown ; the injection is coarse, and the membrane is extremely dull and perfectly opaque : its surface is quite lustreless, rough, and, as it were, rugous. It is much thickened too, for not only are the membrane itself and the subserous cellular tissue infiltrated, but also other adjoining structures, especially fibrous structures, which are closely connected with the diseased membrane ; and the infiltrated matter gradually solidifies in them all. Hence the serous membrane is increased in density and compactness, and cannot be so readily torn as in its natural state, but it may with ease be stripped off the subjacent tissue.

The persistency and occasional exaggeration of the process render the exudation always an abundant one ; for the inflammation is on the one hand continually adding to its amount, and on the other preventing its absorption. The exudation is always characterised by the small quantity of its plastic portion, and the excess of that which is not coagulable. The former portion consists of a plastic layer upon the inner surface of the membrane, of a pale reddish, or grayish, colour, and of slight thickness ; the latter is a perfectly clear, a pale yellowish, or a greenish, serous fluid : sometimes it contains a certain quantity of coagulable matters of little plastic power, which swim about as soft albuminous flakes, or form a shaggy precipitate on the inner surface of the original deposit, or lastly coagulate in large lardaceous masses, which usually occupy the deepest space in the serous cavity.

When the inflammatory process subsides, the serous effusion

is gradually absorbed: if any of it remain and prevent mutual contact of the walls and duplicatures of the serous membrane, the plastic exudation increases in density, yields up the moisture (water of crystallization) contained in it, and changes into a firm cellular, or rather into a fibro-serous plate: but if the serous fluid be entirely absorbed before the organization of the plastic part is completed, the latter forms a dense fibro-cellular bond of adhesion, with which the serous membrane intimately unites, and seems identified.

3. An inflammation originally acute may, after having deposited its exudation, become chronic. Such a termination of an acute inflammation occurs chiefly when its exudation is one which degenerates into pus, or is actually purulent; and there is no question, that the state of chronic inflammation is kept up by the contact of the membrane with the exudation.

The serous membrane seems changed into a spongy, granulating layer, which is coloured with various shades of red; it secretes a purulent exudation, or one that degenerates into puriform matter; and a yellow soft villous coating, which is in process of solution, or a somewhat thick pus adheres to the interior:—the serous sac is converted into a closed or encysted abscess.

In the most favorable case, such an effusion is entirely absorbed after the subsidence of the inflammation; the serous membrane and the organizable substance which clings to and invests it gradually change into a dense fibro-cellular tissue, and the opposite laminæ of it unite in one tough adhesion. During this process, the serous membrane, as such, is, in fact, destroyed.

In other cases, the exudation, after having lost some of its constituent parts by absorption, and undergone a change in its ingredients and elementary composition, is subjected to various metamorphoses: while the serous membrane, and the layer investing it become converted into a dense fibroid plate. The exudation is gradually inspissated, forms a cream-like, and afterwards a cheesy, whitish yellow, pulp, and in the end becomes chalky: or else there remains behind, within the false membrane,—probably as a consequence of the exudation containing in abundance of animal lime.—a whitish fluid like lime-water, which incrusts upon the inner surface of the membrane,

and renders it smooth and polished like gypsum, or rough and sandy, like mortar. Or lastly, the pseudo-membranous sac contains a fatty glutinous fluid, which is, for the most part, of a brownish-yellow colour, and is mixed with numerous minute glittering scales, (fat-crystals,) which cling in thick clusters to its inner surface.

In the most unfavorable case, the purulent exudation becomes sanious, and for the most part, of a greenish colour; at the same time, in some instances, gas is evolved, and the exudation assumes a most offensive pungent odour, like that of garlic, phosphate of ammonia, or sulphuretted hydrogen. Under these circumstances, the serous membrane not unfrequently ulcerates, or sloughs at some small and circumscribed, or at larger spots; sometimes the ulceration extends into the subserous structure, an opening of the serous sac takes place, and its contents are spontaneously discharged either externally or into another cavity. (*Phthisis membranæ serosæ ulcerosa.*)

γ. Chronic inflammation may extend from the serous membrane to the pseudo-membranous structure which lines it, and lead to a deposition of its products both within the substance, and on the internal free surface of the new structure: that is to say, the exudation deposited by one inflammatory process may itself become the site of a new inflammation during the time that it is becoming, but is not yet completely, organized. This explains the otherwise unintelligible occurrence of exudations upon the inner surface of serous membranes, which have already become converted into thick fibroid rinds, while effusions, to all appearance quite recent, have taken place into the cavity.

This secondary inflammatory process, occurring during the progress of organization in the plastic product of a previous acute, or even of a chronic, inflammation, deposits exudation both upon the free surface of that product, and also within its tissue or parenchyma: the former constitutes a second free exudation, the latter an infiltration. The infiltrated product, during its organization, becomes an integral part of the original exudation, and renders it thick and very dense, compact in its parenchyma, and of fibroid or fibro-cartilaginiform structure: the stratum thus formed becomes identified with the serous membrane.

The free exudation may be, and usually is, a plastic one, with

more or less also of an aplastic portion ; it may, however, present any of the qualities, and undergo any of the metamorphoses, already detailed : indeed, the inflammation within the parenchyma of the exudation may even have a suppurative tendency, and abscesses may be formed in it, analogous to those which occur in the subserous cellular tissue. The new plastic exudation becomes organized into a cellular tissue, and unites with the older layer of exudation beneath it ; and it again may be attacked by inflammation, and become callous and indurated.

In this manner tough, fibroid laminæ are formed upon serous membranes, which, if the process be repeated often enough, may measure three or six lines, and even an inch and more in thickness : they are united externally with the serous membrane, to which they become firmly and immovably fixed, or even with adjoining fibrous expansions, aponeuroses, periosteum, &c.

If no further inflammatory process take place in the last exuded layer, that layer becomes organized to cellular tissue ; and if none of the effused fluid remain at the termination of the process, and the opposed layers come into contact with each other, they unite into a single layer, and the serous cavity is obliterated in whole or in part, according to the extent of the process. But if any of the earlier, or of the more recent, fluid effusion be still left, it is either kept encysted by the impermeability of the fibroid stratum, and the slight power of absorption which it possesses, or else it is slowly diminished in quantity by absorption. Whilst the serum is gradually being absorbed, the plastic (albuminous and gelatinous) matters which it contains are precipitated upon the walls of the fibroid exudation, and form a loose villous lining for it ; or else they accumulate in one shapeless mass, and become encysted in some part, generally the most dependent part, of the cavity. If under such circumstances, the walls of the serous cavity approximate and fall together, the layers of the exudation will be agglutinated to one another by means of a stratum of grayish jelly-like substance, into which the precipitate just described changes, and which Laennec, from his observations of it in pleuritic exudations, compares to the central part of the intervertebral substances. In the end it becomes converted into a dense compact cellular tissue.

This process is mostly observed upon the pleura, and will be more particularly referred to amongst the diseases of that membrane.

An exudation of a peculiar nature is very frequently found upon serous membranes, and requires particular notice. Its true character was first discovered by Laennec, who named it the hemorrhagic exudation. It is usually large in quantity, and consists of fibrin, blood corpuscles, colouring matter of the blood, and serum mixed in different proportions, and it is chiefly distinguished by its more or less intense red colour.

The conditions out of which it arises are general and local. Those of the former kind include diseased states of the blood, particularly tuberculosis; the anomaly in the composition of the blood, which results from cirrhosis of the liver; the scorbutic constitution; and, that which is allied to the last two, the dyscrasia of drunkards. Besides these, there are, of course, red and variously discoloured exudations, which proceed from decompositions of the blood, such as succeed exanthemata (variola and scarlatina), typhus, &c.

The following are the local conditions of its occurrence:—The hemorrhagic exudation, though it sometimes, no doubt, results from primary inflammation of a serous membrane, yet is far more frequently the product of the third-mentioned form of chronic inflammation, *i. e.* of a secondary inflammatory process occurring in a plastic exudation; and this is, in fact, the cardinal local condition under which it takes place. For the structure in which the inflammation occurs is in course of organization; its vessels are only just forming, and have as yet no actual coats, or, at any rate, but very delicate and permeable ones; and they have not yet united into a freely inosculating circulatory system: from such a structure the exudation occurs, without question, repeatedly and at intervals, and probably also prematurely before the congestion has reached the degree of intensity which would, in any other structure, be necessary to produce it. The whole process bears throughout it the stamp of an inflammation which has not arrived at maturity: and its product is blood, altered by congestion in the composition, and mutual relation and intermixture of its elements. The fibrin, blood corpuscles, and colouring matter contained in it vary with the state of the constitution, and with

the composition, but more particularly with the stage of organization of the substratum itself. It is remarkable, that it coexists very frequently with tubercle in the same substratum.

Note Tubercle in Serous Membranes.

Where the hemorrhagic exudation-process borders upon actual hemorrhage is manifest, and so is also the mode in which they are to be distinguished. The process is seen upon all serous and synovial membranes, but especially on the pleura and peritoneum; it is met with also in the pericardium, and in the tunica vaginalis testis; and, amongst synovial membranes, principally in the knee-joint.

The thickness and consistency of the hemorrhagic exudation are proportioned to the quantity and plastic properties of the fibrin it contains: it forms a peripheral coagulum, which cleaves to the walls of the serous cavity, and may contain more or less colouring matter, or may be white. The red fluid effusion is enclosed within the peripheral coagulum, and out of it further plastic ingredients are precipitated. These ingredients in process of time, are converted into a very tough leather-like layer, which undergoes very little or no organization; the fluid effusion gradually assumes a chocolate brown, a plum sauce, or a yeast yellow colour, and becomes fatty and glutinous; while the substance precipitated from it degenerates into a loose pulp of the same colour; or it deposits its colouring matter, and becomes a clear serous fluid.

The hemorrhagic effusion is but rarely reabsorbed, and with much difficulty when it is. The reason of this difficulty is sometimes the continuance of a chronic inflammation, and the frequent coexistence of tubercle with it, in the stratum from which it was poured out, and sometimes the density, the impermeability, and the extremely incomplete organization, of the plastic layer that surrounds it. When it occurs on large serous membranes, it usually proves rapidly fatal by the exhaustion it produces, or by its interfering with the function of important organs; and the more rapidly in proportion to the amount of general disease that coexists with it. It is, however, sometimes borne for a long period, and under favorable general and local circumstances it may be diminished by absorption. If, in the most favorable case, it happen, that the fluid is completely removed and the peripheral laminæ are

agglutinated to one another, a rust-coloured, or yeast yellow layer is found interposed between them. In the peritoneum chiefly, and more particularly on that part which belongs to the intestinal canal, the plastic layers of the hemorrhagic exudation acquire a bluish colour, and after a time the colour of Indian ink (*melanosis stratiformis*). No doubt the discoloration is owing to the action of the intestinal gas.

In course of time, the fibroid exudations frequently become the seat of calcareous deposition; and yellow, grayish, or dirty white cheesy masses of various sizes are not unfrequently found in the cellular, as well as in the fibroid, layers of exudation. They are portions of plastic exudation which have not been organized; degenerate fibrin, which, either decaying further and becoming puriform, excites inflammation and actual suppuration and ulceration in the neighbouring tissues, or else changes into a chalky concretion.

The termination of inflammation of serous membranes in *suppuration* has been already considered.

Sloughing or necrosis of serous tissue is very rarely met with as a consequence, or degeneration, of an inflammatory process; but it frequently results from the membrane being stripped of its subserous tissue, when that has been destroyed by suppuration or sloughing; or from pressure, stretching, or strangulation of the membrane; or when adjoining structures are also sloughing, or have become gangrenous some time previously, as in the instance of gangrene of the lung. Sloughy serous tissue forms a dirty yellowish, or a whitish, soft eschar, as is seen in the case of perforating ulcers of the stomach or intestines, or of strangulated herniæ; or else it is a loose shreddy, grayish, or blackish brown, moist, infiltrated, and pulpy mass, which is traversed by a dirty white thready tissue; it has the odour peculiar to slough.

The termination of inflammation in *tuberculosis*, or rather the metamorphosis of its product into tubercle, will be considered presently.

The state of the tissue beneath the serous membrane during inflammation is a point of considerable practical importance. The condition of the sub-serous cellular tissue, as has been already mentioned, is an integral part of the whole process. The more intense the inflammation is, and the longer it con-

tinues, so much the more do that and the adjoining tissues take part in it. Inflammatory products of various kinds are deposited in all of them, and become infiltrated, or give rise to diffused or circumscribed suppuration, or to chronic, and very considerable, thickening. The most important part is that which is taken by adjoining fibrous tissues, whether aponeuroses, capsules, or ligaments. Another remarkable fact is, that the tissues lose their vital contractility: muscles, under such circumstances, become paralysed and lose their colour. Very intense and chronic inflammation leads at last to atrophy of the subserous structures, partly by the change of texture which is produced by the inflammation, and partly in consequence of their protracted palsy. The viscera contained within an inflamed serous sac are displaced and compressed to a degree and extent corresponding to the quantity and the position of the exudation; and when this is long continued, they undergo various changes of texture, which may be included generally in the terms atrophy, obsolescence, obliteration.

Whichever of the forms that have been described the inflammation assume, it may be general in its extent, or only partial and circumscribed. It is remarkable to observe, that usually—though there are various exceptions to this rule—the parietal layer of serous sacs suffers more than the visceral, and that, therefore, the plastic exudations on it are the thicker.

3. *Softening of serous membranes.*—There is no such disease as primary softening of these membranes: when it does occur, it is consecutive, and in the peritoneum and pleuræ, ensues upon prior softening of the stomach, intestine, œsophagus, and lungs. The mode in which the serous membrane suffers is the same as has been described in the account of those diseases.

4. *Adventitious growths.*—Some of these have been mentioned as products of inflammation. There remain to be noticed:

a. *Lipoma.*—This occurs in subserous cellular tissue, but is an unusual disease; it consists generally of a small and lobulated mass of fat, which projects into the cavity of the serous membrane. A somewhat remarkable form is that described by J. Müller under the name of *lipoma arborescens*; it occurs on synovial membranes, especially in the knee joint.

b. *Cysts.*—These, on the whole, are rare growths on serous

membranes; though there are exceptions to such a rule in the instance of some serous membranes, and even of particular regions and particular prolongations and duplicatures of them. Thus in the peritoneum, for instance, cysts are frequently found on that part which invests the sexual organs of the female, especially on the broad ligaments and peritoneal coverings of the ovaries and fallopian tubes; on the great omentum the same is the case, and on the tunica vaginalis of the testicle, which in this respect bears a remarkable analogy to the sexual portion of the peritoneum in the female. Equally remarkable is the fact, that when cysts are formed on serous membranes, it is chiefly on portions connected with organs in which cancer is of frequent occurrence.

There are two different ways in which cysts are developed; and in this respect their development is analogous to that of secondary cysts upon and within anomalous serous and fibro-serous membranes. In one case, the cyst is formed upon the inner free surface of the serous membrane, and for the most part is a vesicle with very delicate walls: such cysts are sometimes very numerous; they are usually of small size, and have broad bases, rarely being attached by a pedicle. In the other case, it is formed deeper in the parenchyma of the membrane or in the subserous cellular tissue—in the wall of the serous sac, and is often situated, as in the broad ligaments, between two serous layers: it thrusts the membrane before it, and at length falling into the cavity, remains suspended only by a serous cord or pedicle, which is sometimes several inches long. Cysts of this kind very often have thick walls, and frequently attain a considerable size: they occur singly or in small numbers, and almost only in the neighbourhood of the internal sexual organs of the female: those which have long pedicles are often observed at the fimbriated extremity of the Fallopian tubes.

The contents of the cysts are most frequently serous; sometimes they are thin and watery, sometimes thicker and mixed with albumen or with a fluid like synovia: occasionally other substances are found in them, which may be colourless or coloured, gelatinous, like gum or glue (colloid), or fatty. Cysts with contents of the last-mentioned kind are often found in the omentum, and sometimes, besides the fat, they contain also hair, bones, and teeth.

c. *Fibroid tissue*.—One form in which this tissue presents itself, is that of *condensation* of the serous membrane, and of the cellular layer beneath it: it assumes the appearance either of milk-white, more or less circumscribed stains, which, after a time, become smooth or uneven plates of various thickness; or of bluish-white, tough, separate granulations (so called *cartilagini-fication* of serous membrane). Another form is that of *fibroid exudation* upon the inner surface of the membrane. The present head might include also the concretions which are found free in serous and synovial membranes, but they will be treated of in a subsequent part of the work. Moreover various fibroid growths found in the synovial membranes of joints, are formed from exudation accumulated in particular spots; they are villous and laminated, or they form clusters of small subovate bodies that resemble melon seeds (Mayo). Bursæ are sometimes filled with balls of exudation which are undergoing a change into fibroid tissue.

d. *Abnormal bony substance*,—*Ossification*, as it is called, of *serous membranes*.—This, like the adventitious substance last described, is found as a subserous formation, on the outer side, and in the substance of the serous coat, after it has undergone a fibroid condensation of its tissue; and it also occurs in fibroid exudations upon the inner surface of the membrane. Its usual form is that of rugged, nodulated plates or cords of various size and thickness. It appeared to Meckel to be the result of an endeavour to convert a membranous into an osseous cavity, similar to that which prevails in the vertebral and cranial cavities. The granular and stalactitic form is less common; but both are sometimes found together at the same spot. Lastly, some shapeless concretions are met with, which are the chalky residue of fibrinous effusions.

The frequency with which serous membrane becomes the seat of ossification is a matter of much variety, depending on the different frequency of the changes of texture which precede it. Ossification occurs chiefly on the pleura, where it is remarkable for its extent and thickness. In the peritoneum it is almost confined to certain investing portions, especially to that covering the spleen; it occurs in the tunica vaginalis of the testicle, and, in the synovial system, sometimes in bursæ.

e. Tubercle.—Tuberculosis of serous membrane.—Tubercle affects chiefly the larger divisions of the serous system; the peritoneum, pleura, and pericardium. It is ordinarily the product of a general constitutional disease, which has been already localized in some parenchymatous organ, and in this sense the tuberculosis of serous membranes usually has some definite starting-point, or prior cause (Ausgangsherd). It sometimes, however, occurs independently of any such previous and causal deposition, and is the primary and only local affection in which the general tubercular diathesis expresses itself. It is, with very few exceptions, the result of a high degree of the general disease, and hence is associated with tuberculosis occurring simultaneously with, or soon after, it in organs which stand in immediate connexion with the membrane. The starting-point for tuberculosis of serous membranes is, in general a previous affection of the absorbent glands, or of the lungs; that for peritoneal tubercle is tuberculosis in the abdominal lymphatic system, in the internal sexual organs of the female, or in the intestines; the cause of tubercle in the pleura and pericardium is found in the bronchial glands and lungs; tuberculosis of the tunica vaginalis testis has its starting-point in the lymphatics of the genital organs, and in the testicle itself; and so on. Peritoneal tubercle is, almost as a rule, associated with the same disease in the spleen, or liver; that of the pleura with recent deposition of tubercle in the lung; and further, tuberculosis not unfrequently appears in nearly all the serous membranes at once, or almost at once, and either in one and the same form, or in the various forms to be described presently.

In some few cases the tubercle may occupy the tissue of the membrane itself, and the sub-serous cellular structure. Generally, however, its site is manifestly the free, smooth surface of the membrane, or it is seated quite within the surface in a false membrane of cellular or cellulo-serous structure that lines the serous membrane. In the former case it may be stripped or broken off from the serous membrane, and leaves behind it a spot of corresponding size, dull, lustreless, often distinctly opaque, and deprived of its epithelium. If it have been of large size, its pressure may have formed a pit, and

then it appears as if it had been seated in the tissue of the serous membrane itself.

Tubercle presents itself upon serous membranes in the following forms :

a. One form is that of the gray, semi-transparent, crude, granular tubercle, the size of which is about that of coarse sand, or millet seed. When chronic, this form of tuberculosis may originate at several parts of the membrane. Commencing at one or more of these starting-points at the same time, it gradually extends over large portions, or even over the whole of the surface : its advance, however, is not uniform, and hence the original depositions may still be recognised by the close grouping, and by the appearance of the granulations. In the acute form, the tubercles are usually abundant, and are sown evenly and close together over the whole expanse of the membrane, or at least over a very considerable part of it. They consist of granular tubercle of the size of millet-seed, or, as is often the case, of transparent, crystalline granulations, resembling vesicles, and so fine as to be perceptible only when the light falls favorably. Acute tuberculosis ordinarily arises out of a more or less lingering (chronic) tuberculosis of the membrane : and in that case, as well as in the rarer instances in which it commences on perfectly healthy membranes, it is usually but a partial manifestation of a general tubercular diathesis, which is exhibiting itself in several structures, either together or consecutively. This fact is one of great importance, from the absolutely unfavorable prognosis which it establishes. Dropsy of the serous cavity co-exists with the tubercle, and is directly proportioned in amount to the extent of the deposit over the membrane : general cachexia and dropsy of other cavities and organs follow in the same proportion. The œdema of the serous and adjoining cellular tissues, the infiltration of the parenchyma with serum of the blood, and the loss of its colour, as well as the thin fluidity and defibrination of the blood generally, are all proportioned to the acuteness of the disease.

This kind of tubercle undergoes scarcely any metamorphosis, for the local disease which gives rise to it, and still more the general, and already far-advanced, constitutional affection, prove

too speedily fatal: sometimes, however, when the course of the disease is chronic, the tubercle is found here and there obliterated, (obsolete.)

β. An inflammatory product, deposited upon a serous membrane under the influence of a constitutional affection,—which affection is usually already localized, and very often is even manifested in established phthisis,—may undergo the metamorphosis into tubercle. The change is induced by some inherent anomaly in the quality of the product, and is effected in various ways. Sometimes the exudation in its whole thickness degenerates into an uniform cheesy, or caseo-purulent, fissured layer, which agglutinates and connects the organs contained in the serous sac to one another, and to the parietal layer of the membrane: sometimes it is partially organized and gradually converted into a cellular or cellulo-serous tissue, while a more or less considerable portion of it becomes tubercle. The layer of exudation is then found in different stages of organization, and interwoven with isolated or confluent, grayish, fawn-coloured, or dirty yellow tubercles, of the size of sand, millet-seed, or hemp-seed, and often with still larger shapeless masses of tubercle. Two species of this form of tuberculosis are in several respects remarkable:

(1.) An exudation in the form of a rugged layer, for the most part of considerable thickness, and of fibro-cartilaginous firmness, which consists of a quantity of confluent granular tubercles, and of a grayish-red, moderately vascular, lardaceo-gelatinous, or grayish, pale, slightly vascular, and lardaceo-callous, substance, in which those rugged masses of tubercle are imbedded. A comparative analysis shows that the *status* of this tubercular layer, as a vascular structure, is secondary, and that it corresponds to the lardaceous infiltration and callous condensation of the tissue of mucous membranes and parenchymatous organs around tubercle, and tubercular ulcers.

(2.) In cellular and cellulo-serous tissue recently formed on serous membranes, especially on the peritoneum, there occur yellow, cheesy or fatty, brittle masses of round or subovate form, and of the size of peas or beans: sometimes they are shapeless, and are as large as doves' or hens' eggs.

This form of tubercle also rarely undergoes any metamor-

phosis; as, indeed, might be expected from the high degree which the constitutional disease, (the dyscrasia,) the preponderating, internal cause of the exudative process, attains; but sometimes the species just noticed—(2)—is seen, on the one hand, softening and leading to suppuration (tubercular phthisis) of the serous membrane, or on the other hand, becoming chalky.

7. Lastly, an exudation upon serous membranes, originally free from tubercle, may, at any stage of its organization, become the nidus of that growth,—a form which, when it is possible, is to be distinguished from that developed in the way described in section β . That such a form exists is probable from two observations, and is not opposed by any positive facts.

1. In chronic inflammations of serous membrane, which occur in the exudations, one of the secondary inflammations sometimes furnishes a product upon the free surface of the older exudation; and that product becomes tuberculous in the manner described in section β ; that is to say, a serous membrane is sometimes found lined with an exudation, the outer and older layer of which is free from tubercle, whilst the inner—the product of a secondary inflammation of the older layer—is tuberculous.

2. In the cellular false membrane lining a serous cavity, covering the peritoneum, we sometimes see tubercle, usually of considerable size—as large as hemp-seed or peas—from the middle and central point of which loose-walled blood-vessels project, and passing to the outskirts of the tubercle, sink deeply, and at the bottom, or else are seen to anastomose with other vessels of the false membrane. Indeed, in a few apt cases, the tubercle is found upon close examination to be excavated by a canal or canal, which forms the centre of this small vascular apparatus. Now, in most instances, the canal is already obliterated, the excavation is obstructed, and the vascular apparatus is degenerated. When the atrophy is accomplished, the tubercle is found imbedded in cellular tissue, which is streaked with redness and vascularity. Such an appearance may give rise to the supposition, that tubercle is supplied with blood-vessels, implying, as I have recommended serous membranes as the substance best adapted for the study of tubercle, because in that

system it may best be followed in all directions. The appearance, however, may be safely explained in the following manner:—The tubercle is thrown out under the influence of a tubercular diathesis by the vascular centres which are forming in the false membrane, and arranges itself around them: the more abundant—the larger—it is, so much the more prominent does it render the vascular apparatus that radiates from its centre.

The tubercle formed upon serous membranes is frequently a hemorrhagic product; especially when it is a result of the processes just described under sections (1) and (2); indeed this is sometimes the case when it is thrown out by a primary exudative process.

The congestion that attends its production not unfrequently degenerates into inflammation, and that, for the most part, furnishes a hemorrhagic exudation, in the same manner, but not to the same extent, as the inflammation of a false membrane in which tubercle is forming. As has before been explained, the hemorrhagic nature of the exudation is owing to the fact of the blood being impoverished in fibrin by the exudation of tubercle, and also in the second case to a local circumstance, viz. the imperfect formation of the vessels in the false membrane.

f. Cancer.—Serous membranes are often perforated by malignant growths which have originated externally to them: the pleura is invaded by masses of cancer deposited in the mediastina, and by large exuberant growths in the mammae; and the peritoneum, amongst other growths, by those which Lobstein has named “Retro-peritoneal.” But cancer appears on these membranes as a primary disease also. As a general rule, its appearance there has some connexion with the existence of cancer in an organ adjoining, or contained within, the serous sac; so that it always shows the cancerous cachexia to be very far advanced.

The most common forms of cancer found on these membranes are the areolar and the medullary; the latter having not unfrequently the melanotic character. It consists either of laminae, which vary in extent and are unequal in thickness; or of small nodules, like tubercle, which germinate in the

tissue of the serous membrane ; or of larger knots and tuberos masses, which shoot forth from the tissue over the surface of the membrane. Moreover, upon the serous layer of the dura mater, numerous morbid growths, allied to medullary cancer, are found, the internal and minute construction of which presents very much variety.

In large serous cavities, such as the peritoneum, there are somewhat rarely found very large adventitious growths, which have the same general characters as those under consideration, but are very loosely connected with the serous membrane by one or a few points, or are even entirely unattached.

If, as often happens, inflammation should attack a cancerous growth on a serous membrane, the result is a hemorrhagic exudation : the explanation of the occurrence is found in the very imperfect state of the vascular apparatus involved in the inflammatory process. (Compare what has been said as to the local causes of hemorrhagic exudation.)

g. Anomalies of secretion, and morbid contents generally.
—Free *gas* is not unfrequently found collected in different quantities within serous sacs. It is met with chiefly in large serous cavities, such as the pleura and peritoneum, and its presence is due to the escape of atmospheric air from the air passages, or of intestinal gas from the bowel. It is occasionally produced by the decomposition of ill-constituted and long-stagnated effusions ; or it may be a product of the exudative process itself. In a few cases, it may even be a morbid secretion (exhalation), from the serous membrane during life.

Besides this, and the various products of inflammation already described, there occur also collections of serous fluid, and of blood.

Collections of *serum* constitute dropsy of serous and synovial sacs, and of bursæ (Ganglia) : the quantity of fluid varies, and with it the enlargement of the cavity ; its colour, too, and its consistence and composition, especially in respect to the quantity of plastic material it may contain, vary considerably. The remarks already made upon dropsy in general apply also here.

The effusion of *blood* into serous cavities—actual hemorrhage—must be carefully distinguished from hemorrhagic exudation.

An account of various other effusions will be found in the chapters on the particular serous sacs.

Lastly, the cavities of serous and synovial membranes sometimes contain free loose bodies, which have various origins, and differ accordingly in their appearance and construction: those, more particularly, which are met with in the peritoneal cavity vary much in their kinds. They are found in the cavity of the peritoneum, within the tunica vaginalis testis, in the pleura, in the sac of the arachnoid, and in the ventricles of the brain; they are also particularly common in several of the synovial cavities, especially in the knee, and in bursæ, (articular mice;) they even occur in anomalous serous sacs.

Their usual size varies from that of a millet-seed to that of a pea or a bean: it is an exception to find them larger, but they do sometimes reach the bulk of a walnut: they are generally round or oval in shape, but pressed somewhat flat; sometimes their figure is irregular. They are mostly firm and elastic; and from the smoothness of their covering, which glistens like a serous membrane, they acquire a polished appearance, but sometimes there are rough and villous spots upon them.

With regard to their origin, the observations of Laennec and Bérclard prove that some of them originate outside the serous membrane; while the internal construction of many others indicates that they were formed within its cavity.

The first kind includes the fibroid and fibro-cartilaginous concretions, some of which contain bony nuclei. They are originally developed in the subserous cellular tissue, or in the serous tissue itself; but as they gradually force the membrane before them, they become invested with a prolongation or duplicature of it, which remains connected with the rest of the membrane only by a pedicle; at length the pedicle being worn away by friction, the cartilage falls loose into the serous cavity. It has a proper serous covering, which often bears a trace of this mode of development in being deficient at the spot where it was separated from the pedicle: it is then completed by loose shreds of cellular tissue.

Those of the second kind are the fibrillated and albuminous coagulations and precipitates from morbid effusions. They are distinguished by their uniform smoothness throughout, by a delicate albuminous investing membrane, and frequently by their manifest arrangement in concentric laminae.

PART VI.

ANOMALIES AND DISEASES OF MUCOUS MEMBRANES IN GENERAL.

§ 1. *Defective and Excessive Development.*—Congenital deficiency of a mucous membrane involves deficiency of the apparatus which it composes, or which, as the expression is, it invests or lines: always, therefore, when the mucous membrane is absent, the whole apparatus is absent too. The only instance of acquired deficiency is a partial loss of substance, and it varies in character considerably according to its cause.

Preternatural development is sometimes an original anomaly, which may be exhibited in a congenital excess in the length and capacity of mucous canals and cavities, in the existence of unusual appendages and duplicatures, or in the unusual size of prolongations and folds which naturally exist in the membrane. Sometimes such an anomaly is acquired: it is exemplified in the similarity that exists between the surfaces of abscesses and fistulæ, and mucous membranes; in other words, as Otto describes it, in the development of abnormal cavities and canals, which, like normal mucous membranes, are connected, or about to be connected, with the surface of the body: it is further illustrated by the restitution of lost mucous membranes.

In regard to the former, whether the lining membrane of the abscess or fistula be composed of cellular tissue, of serous membrane, or of any other structure loosened in its texture so as to resemble cellular tissue, it is at first a granulating vascular layer closely connected with the subjacent structures; but afterwards it becomes a more distinct membrane, and may be isolated from them: its free surface may be smooth, or may be covered with shreddy appendages and prolongations. In its structure it has a general resemblance to mucous membrane; but inasmuch as it has few follicles and no actual villi, it is

and villi altogether disappear: its surface is pale and smooth, and glistens like a serous membrane. A similar attenuation is observed in the mucous membrane surrounding various extensive losses of substance, both during and after their repair. And there is yet another instance of the same condition, in which certain parts of the mucous system not only become extremely thin, but also undergo a change of texture: it is a consequence of the gradual and excessive distension which is produced by the accumulation of matters secreted during some occlusion of the cavity. This subject will be further considered.

§ 3. *Diseases of texture.*—Both acute and chronic diseases of mucous membrane are, as is well known, exceedingly frequent; and hence, as well as from the manifold connexions which they maintain, both in their origin and consequences, with other systems and organs, they are diseases of great importance. For the most part, they are the result of that sensitiveness to all changes in the material components of the fluids,—whether immediate (primary), or produced through the medium of the nervous system,—as well as to all deviations from the proper evolution and distribution of the imponderable principles, which attaches to mucous membrane, as the most vascular of all structures, and the chief organ of absorption and secretion. Hence almost all acute (febrile), and many chronic, constitutional diseases establish themselves in various ways, the former rapidly, the latter gradually, upon these membranes. There are various processes, irritative and inflammatory, by which this is accomplished; but in the present chapter only the cardinal forms will be treated of, the catarrhal, the exudative, and the pustular; the other specific processes of the same class will be found described amongst the diseases of the separate portions of the mucous system.

1. *Hyperæmia, apoplexy, hemorrhage, anæmia.*—Mucous membranes are sometimes actively congested, either in consequence of some direct irritation, or from a special relation of the constitution of the blood to a particular portion of the membrane: sometimes the congestion is passive, and occurs as a consequence of marasmus and adynamia, particularly in the tracts of membrane lining the respiratory organs and intestinal canal. Again, it may be mechanical, and extend

over large areas, and even over the whole of large divisions of the mucous system: the congestions which are found in the respiratory organs and intestinal canal in diseases of the heart, lungs, and liver, are of this kind.

It presents various degrees. In the ordinary and slight degree, it either entirely disappears after death, and the membrane, whatever may have been its state during life, is found pale; or the ramifications of veins, or perhaps the capillary vessels are full of blood, and the membrane is red and injected. When it has been acute, it leaves the membrane swollen and relaxed, and more or less evidently succulent, while the mucous and sub-mucous tissues are slightly œdematous: when chronic, it occasions thickening and hypertrophy of the membrane, and a permanent increase of its secretion of mucus.

In a higher degree, the congestion advances to vascular apoplexy, and apoplexy is followed by bleeding into the parenchyma, and from the surface, of the membrane: the more rapidly the congestion has arisen, or been augmented, the sooner does the hemorrhage take place. These occurrences are met with chiefly in the bronchi and alimentary tube, where they may arise either from active, or passive, or mechanical congestion. The mucous membrane appears red and swollen, from its injected capillaries standing thick together; or dark-red and tumid, from injection that cannot be distinguished from effusions of blood into the parenchyma; or, lastly, more or less blood is found upon its surface, or collected in the cavity which it encloses, while it is itself either in one of the states just mentioned, or collapsed, pale, and bloodless.

It must, however, be remarked, that bleeding from mucous membranes in general, excepting that from the bronchial membrane, is rarely the result of mere congestion; for the most part, and in the case of the stomach and intestinal canal especially, the hemorrhage proceeds from some other part of the membrane, which is diseased in texture, though it very often appears quite trifling in extent, or may be so small as to be scarcely discoverable.

Anæmia in mucous membranes is the result of diminution of the general mass of the blood, and especially of loss of blood by hemorrhage; it is, therefore, only a local symptom of general

anæmia. The pallor which ensues, under such circumstances, especially in the mucous membrane of the intestinal canal, where it proceeds chiefly from gelatinous softenings, presents a remarkable waxen hue, and a yellowish shade of colour.

2. *Inflammations.*—*a. Catarrhal inflammation.*—This is the common inflammation of mucous membrane; it is sometimes an ordinary catarrh, resulting from the known atmospheric influences; sometimes it is the local expression of a constitutional disease, and is then a specific catarrh, either exanthematous, typhous, impetiginous, gouty, or the like: occasionally it is produced by direct mechanical or chemical irritants, &c.; moreover it accompanies the various processes of ulceration and new growth that take place upon mucous membranes, varying in such cases both in intensity and in extent. Its course is sometimes acute, sometimes chronic.

a. Acute catarrhal inflammation.—The anatomical characters of this disease are as follow:

(1.) Redness, which varies from a pale rosy tint to a deep red: it gradually diminishes towards the margin of the inflamed spot, and then passes into the natural colour of the tissue.

(2.) The injection may involve merely the finer ramifications, or it may amount to a complete distension of all the vascular apparatus, and will, therefore, vary in each membrane according to the special arrangement of its peripheral vessels. To the unassisted eye, the membrane then appears uniformly saturated with red.

(3.) Even with a slight amount of reddening and injection, the inflamed membrane loses its transparency, and becomes cloudy.

(4.) Its tissue becomes filled with an opaque grayish, or a sanguineous, grayish red, fluid, and the membrane appears swollen: the papillæ and mucous glands being in the same condition, its surface seems warty or papillary, and uneven. Sometimes the epithelium is raised in delicate, translucent, miliary vesicles which are filled with a serous fluid.

(5.) It may be easily torn, and readily separated from the structures beneath. These structures, and especially submucous layers of cellular tissue, are loose, filled with a serous or sanguineo-serous fluid, spotted here and there with small extravasations of blood, and fragile.

6.) At the commencement of the inflammation, the secretion exceeds the natural quantity, and is watery: as the inflammation advances, it diminishes in amount, and becomes opaque and thick: at the acme of the inflammation, it ceases altogether. After this it is gradually restored again, and is frequently tinged with a little blood: it then assumes a purulent appearance, and becomes very abundant; and remains in this condition some time after all other marks of the inflammation, even the swelling of the tissue, have subsided. This is especially the case in mucous cavities.

In addition, inflammations of very great intensity deposit a more or less plastic exudation upon the free surface of the membrane: the miliary vesicles upon catarrhal mucous membranes which were mentioned above, arise from this cause.

Acute inflammation often has a marked tendency to return after slight occasions: severe attacks of it frequently terminate in superficial suppuration, which may even continue habitually. Incommodum it becomes chronic.

Chronic catarrhal inflammation.—The anatomical characters of this form of inflammation are,—

(1.) A dark, dull redness inclining to brown, injection, and a varicose state of the vessels.

(2.) Increase of bulk: the mucous membrane becomes thick and tumid; the swelling of the papillæ and follicles renders its surface uneven, especially if the process have been of long duration and the glands be abundant: its tissue, becoming denser and more compact than natural, is hence also—

(3.) Tough and resisting, and is with difficulty torn: it is more firmly connected, too, with the subjacent tissues, and they become swollen, dense, and tough (hypertrophied).

(4.) The secretion is a grayish or yellowish gray, opaque, viscid mucus.

Chronic inflammation usually leaves behind it a permanent tumefaction, or hypertrophy of the mucous membrane, and a continual excessive secretion of a grayish white and milky, or of a glassy transparent pasty mucus,—a blennorrhœa, which may or may not be attended with an exuberant formation of epithelium, and in which, accordingly, the epithelium is either rapidly thrown off from an almost bare, and, as it seems, excoriated

mucous membrane, or accumulates over the whole, or over parts, of the surface, and thus forms a complete laminated covering for it, or patches of various thickness here and there upon it.

The hypertrophied membrane itself is pale, or more commonly of a rusty brown, or slate gray, and after a time, of a dark blue colour; it is thick, compact, and firm: when it is uniform in thickness its surface is smooth; sometimes, from the great increase in the size of its papillæ and follicles, it is warty and rugged; and lastly, even various duplicatures and prolongations may be formed upon it.

The two last-mentioned inequalities of the membrane are permanent, immovable folds of the membrane: they constitute what is called the mucous or cellular polypus, or the vesicular polypus.

These polypi are processes of the mucous membrane of various thickness and length. In shape they are spheroidal or elongated, or like nipplepins or cylinders; and their free extremity is thick and blunted. The mucous membrane and the tissue beneath it becoming hypertrophied at particular round circumscribed spots, form a somewhat flattened convex tumour, and progressively change into a honeycombed cellular tissue. Little by little the tumour drops into the cavity of the organ, dragging with it the surrounding mucous membrane, by which, as by a comparatively thin, and more or less elongated pedicle, it remains attached. The polypus then consists of a cylindrical prolongation of mucous membrane, which contains a cord of submucous tissue, and of a truncated extremity or knob, at which the tissue proceeds to form itself into a honeycombed cluster of vesicles and follicles, and becomes lobulated like a cauliflower; it presents a system of dilated capillary vessels; now and then it becomes turgid; it secretes a jelly-like mucus in its interstices, and when that is discharged, it shrinks.

Polypi do not occur with equal frequency on all mucous membranes. They are especially frequent upon those membranes, and parts of membranes, that are bulky and thick, and have abundance of follicles, and that are frequently attacked with catarrh. Such are the Schneiderian membrane, the mucous coat of the stomach, especially its pyloric half; that of the large intestine, particularly of the rectum; and the mucous membrane of the uterus, more especially about its cervix. The

cellular polypus occurs, but less frequently, in the pharynx, the larynx, and œsophagus, in the small intestines, the urinary bladder and urethra,—though it is somewhat frequent in the female urethra: it is extremely rare, and indeed almost never occurs, in the trachea and bronchi, in the Fallopian tubes, and in ducts generally.

Their catarrhal origin explains why they occur in such great numbers, whether separately or, as they mostly exist, in clusters, upon one mucous membrane.

In their thrusting the mucous membrane before them as they enlarge, and in their even protruding into a cavity, and hanging in it by a pedicle of mucous membrane, the form of the polypus is often imitated by various new growths in the submucous structures, especially by lipoma, fibroid tumours, and even by cancer. Several of these new growths have been distinguished from the mucous polypus by the names of fibrous and fleshy polypi.

A point of some importance is the condition of the submucous tissues during catarrhal inflammation and blennorrhœa. The increased sensibility of the mucous membrane gives rise to very frequent reflex movements in those which are irritable, and when the course of the process is chronic, they become hypertrophied, as well from the permanent increase in the quantity of fluids arriving in them, as from the process itself. At length, if there be much hypertrophy, the irritable and contractile submucous tissues gradually become paralysed, and their respective cavities and canals are permanently dilated.

Moreover, chronic catarrhal inflammation sometimes terminates in suppuration and ulcer,—an event which more frequently occurs, and with more rapidity, when an acute inflammation supervenes. In that case the redness becomes more vivid, and seems as it were identified with the mucous membrane, while the membrane itself is changed into a friable tissue, is swollen with blood, and resembles a sponge, or a spongy gland. Matter appears, either extended, as a more or less smooth coating, over the surface of the membrane, or collected in small quantities in its substance; and in this manner the tissue gradually disappears,—the whole process constituting the catarrhal (simple) suppuration, or catarrhal phthisis of mucous membrane. It leaves behind it an ulcerated

breach of substance, corresponding in size to the extent of the inflammatory process,—a catarrhal ulcer, which may be limited by, or may extend deeply into, the adjoining submucous tissue. If, in the former case, the ulcer be small, it heals readily, its base becoming a dense cellular tissue, and the surrounding mucous membrane being drawn in, and at length becoming adherent, over it. An ulcer of larger extent acquires a fibro-callous base, but does not cicatrize; it remains bare, and sometimes obtains a smooth covering like serous membrane: in canals with soft walls its tendency to shrink occasions strictures; and it often, from the application of various powerful agents, becomes the seat of chronic inflammation or of gangrene, sloughs away, ulcerates anew, &c. The character of the catarrhal ulcer probably varies according to the nature of the catarrh.

Both acute and chronic catarrhal inflammations, and the various processes in which they terminate, may affect the follicles of a mucous membrane principally or alone. The walls of the follicle then redden, and the parts adjoining, as well as the follicle itself, become injected, tumid, and enlarged: its secretion diminishes in quantity or is suppressed; but sometimes it is more abundant than natural, and either pours freely forth, or being retained in the cavity of the follicle, becomes inspissated, and undergoes various other secondary changes. The result of this process sometimes is a permanent enlargement (hypertrophy) of the follicle, a dilatation of its cavity, or an habitual profuse secretion of a tenacious glassy mucus—*follicular blennorrhæa*. Sometimes the process terminates in *suppuration of the follicle*, and *follicular ulcer*. It becomes converted into an abscess, which usually bursts through, and discharges itself upon the internal free surface of, the mucous membrane: a small, round, crater-like ulcer is then found situated at the top of a rounded conical tumour, and having a hard base: as the suppuration of the follicle proceeds, the ulcer becomes larger and shallower, and when the follicle is quite destroyed, is encircled by a border of loose mucous membrane: it then extends superficially, or, which is rarer, deeply amongst the submucous tissues.

This process is mostly seen on membranes which have follicles in abundance, and are disposed to catarrh; on that of the air-passages, for instance, particularly in the larynx; or in the

intestinal canal, especially in the large intestines, where it produces very extensive devastations.

b. Exudative processes.—Processes of exudation are frequently met with in particular portions of the system of mucous membranes: but their nature is very various, as their products, and the condition of the mucous membrane in connexion with them, manifest.

The best known exudative processes upon mucous membranes are those named croupy inflammations, especially those that occur in the pharynx and air passages. They are characterised by their plastic product, which varies in consistence from that of cream to the toughness of leather, and is grayish white, or yellowish and fibrinous: it sometimes covers the membrane at a few insulated spots, and sometimes forms a more extensive film over it like hoar-frost; occasionally it invests the membrane like a layer of gauze, while in some cases it constitutes a membranous, and very often a tubular, lining for the mucous surface.

From all analogy it is probable that, at the commencement of the process, a serous fluid is effused, by which the epithelium of the diseased mucous membrane is destroyed, and that the exudation of the plastic matter takes place afterwards. This matter, the general characters of which have just been depicted, forms in a severe case a membranous coagulum, the thickness of which may vary, but not unfrequently equals, or even exceeds, a line: towards its margins it is thinner and less tough, and it is at length lost in a layer of muco-purulent substance. At first it adheres to the mucous membrane, and on that surface which adheres to the membrane some incipient vascularity is sometimes seen in the form of small bloody points; some of these points are single, others divide into fine twigs towards their peripheral extremity. At a later period, a viscid, muco-purulent fluid is effused beneath the plastic exudation, so that it becomes loose, and is at length set free.

The mucous membrane underneath the exudation is variously tinted, but for the most part is of a very pale rosy colour: it looks sore and excoriated, and is more or less swollen, and its papillæ especially are distinctly swollen: its surface is covered with numerous red, soft, bleeding spots like granulations, which correspond to the vascular points on the adherent surface of the

exudation. The submucous tissues, especially the cellular tissue, appear infiltrated.

Neither during nor after the croupy process does the mucous membrane suffer any material injury to its texture: the speedy production of mucus and epithelium prevents any further organization of the plastic exudation beyond the rudimentary condition just described, and it never enters into an organic connexion with the mucous membrane.

The croupy process occurs on all mucous membranes, and sometimes extends over a very wide tract. The mucous membrane of the respiratory organs shows an especial tendency to it, and we meet accordingly with laryngeal croup, tracheal croup, bronchial croup, and croupy pneumonia. In those parts, and on the inner surface of the uterus after childbirth, it is very often a primary process; while on most other mucous membranes it is only secondary, and occurs principally as a consequence and an expression of the degeneration of an exanthematous, or typhous, or some other process attended with exudation, such, for instance, as the cholera process; it arises also from pyæmia, &c.

Other exudative processes give rise, either from the first and exclusively, or else after furnishing, or whilst furnishing, a plastic product, to a loose, pulpy, puriform or sanious exudation, of a variously shaded brown and green colour, and a very offensive smell. The mucous membrane, under such an exudation, softens to a pulpy, or a shreddy and crumbling mass, which has an offensive smell and the same colour, or may be also dark brown, chocolate-coloured, or like coffee grounds from hemorrhage. These processes are named *putrefactive*, and may be primary, but they are much more frequently secondary.

A special form in which these exudations appear, is that of the benign and malignant aphthæ,—exudations, that is, which, at first at least, are confined to rounded or oval spots. They are most common by far on the mucous membrane of the mouth and pharynx; they do, however, occur on all other membranes, but are then generally secondary. The process of softening that goes on beneath the exudation occasions a loss of substance in the mucous membrane, that may be called an aphthous ulcer.

Other exudative processes, which for the most part extend

over large portions, or the whole tract, of a mucous membrane, furnish products that are either albuminous, jelly-like, and pellucid; or milky, mixed with delicate fibrinous flakes, and pasty; or thin fluid, mostly serous, and of a very pale grayish white, yellowish, or reddish colour, or quite colourless. They run their course, sometimes with moderate redness and injection, sometimes with remarkable paleness of the mucous membrane, with tumefaction, infiltration, and at length softening and removal of the epithelium, with softening of the tissue of the membrane itself, and degeneration of it to a pale-grayish, yellowish, rosy, or dark red stratum that is apt to bleed, and may be wiped off like pap, and with similar softening of the follicles. Such processes are, for the most part, secondary, and their chief seat is the mucous membrane of the intestinal tract. The most remarkable of them for extent, for quantity of product, and for the rapidity of its course, has been learnt in modern times,—the Asiatic cholera.

In very severe cases of the exudative process, the submucous muscular tissues become paralysed: they are blanched, relaxed, and infiltrated.

c. *The Exanthematous processes* upon mucous membranes are allied to the exudative. They are sometimes the manifestation of a very great degree of constitutional disease, and form a complementary addition to eruptions on the general integuments; sometimes they are vicarious with the crisis of an exanthema upon the skin, which, from various influences that we are ignorant of, is insufficiently developed; and sometimes they constitute a specific eruption, arising from a special relation between the general disease and a particular tract of mucous membrane,—*mucous exanthema*, as it has been lately denominated. The seat of the two former kinds is chiefly mucous membrane where it adjoins skin, but to a certain extent also it is found where mucous membrane is connected with the original "*atriis morbi*;" such as the lining of the mouth, pharynx, tracheal passages, conjunctiva, or urethra: the last kind, on the contrary, is confined to particular parts of the mucous system, as to the ileum in typhus, and the colon in dysentery.

The following are the forms observed: diffused or circumscribed redness or spots,—*erythema* which sometimes, by their

ulcerative processes of the parts of the mucous system are separately adverted to.

4. *Œdema of mucous membranes.*—All the processes already described, especially the exudative and exanthematous, are attended with œdema; and so also is the ulcerative, in various degrees and to various distances from the actual seat of disease; but œdema may originate also in the submucous cellular tissue, in consequence of many primary and secondary congestions and inflammations which occur in it and in its neighbourhood.

The usual seat of the infiltration is the submucous tissue. It generally forms a pale yellowish or grayish, translucent and tense, or a flabby and moveable swelling, not distinctly circumscribed, over which the upper layer of the mucous membrane is stretched: when it is considerable, it extends through the whole thickness of the mucous membrane also, which then loses the character of its structure, and may be torn with the slightest effort.

The œdema reaches its higher degrees chiefly on membranes, and duplicatures of membrane which are extended loosely and moveably over thick strata of cellular tissue, especially upon the mucous membrane of the intestines and their valves and folds, and the duplicatures at the orifice of the larynx.

Its importance depends upon the processes which occasion it: it is only at certain parts that it becomes at all serious, as at the glottis, where it contracts and at last closes the orifice.

5. *Deposition—Metastasis—on mucous membrane.*—This on the whole, is an uncommon appearance. It sometimes presents the character of a small collection like a furuncle, and sometimes forms a flat scale over the superficial layer of the mucous membrane. It ends in ulceration or in slough, according to the nature of the poison in the blood by which it is occasioned.

6. *Mortification of mucous membrane.*—Mortification presents itself in various forms: the mucous membrane may become a grayish-white, or whitish-yellow, dry and rotten, or moist and lacerable, eschar: such is the change that results from pressure in strangulated hernia, from excessive distension and extension, or when it is separated from the subjacent tissues, through which it is supplied with blood-vessels.

Or, after having suffered absolute stagnation of the current of blood, it may degenerate into a dark brown, or dark greenish, shreddy, friable substance, which gives out the extremely offensive smell of sphacelus, and is more or less infiltrated.

Or else, during the softening of an inflammatory product, which is infiltrated through the tissue of the membrane, and generally also is combined with an aphthous exudation upon its surface, diffused, or more commonly, circumscribed portions of the membrane degenerate into a shreddy and crumbling, or an uniformly pulpy mass, that is variously discoloured, and has a very offensive odour.

When affected with the actual sloughing described under the first-named forms, the mucous membrane generally shares that condition with other adjoining structures.

7. *Softening of mucous membranes.*—If we exclude from consideration the relaxations of tissue that mucous membranes suffer from inflammation and œdema, and the solutions which take place during and after exudative processes, we shall still find conditions occurring on some mucous membranes, particularly in the stomach, œsophagus, and intestinal canal, which differ entirely from the former, both in their causes and in their anatomical characters,—conditions which are included within the term *softening* in its restricted sense: they will be found treated of amongst the diseases of the apparatus in which they occur.

8. *Change of texture which mucous membrane undergoes when preternaturally exposed to atmospheric air, and when long subjected to distension.*—a. The mucous membrane of prolapsed and everted organs is liable to the former kind of change. At first an acute inflammation attacks it and occasionally rises to considerable severity, but afterwards it becomes chronic, and at length terminates in induration. Such membranes become dark red and swollen; their secretion soon increases in quantity, and then they produce a puriform moisture: they may even clothe themselves with a plastic exudation, while underneath they appear raw and excoriated. At length the inflammation moderates, the secretion just mentioned ceases, and the redness diminishes, but the membrane remains thickened, and its texture more compact than natural; it is covered

with a thick, closely-adherent layer of epithelium, and hence appears dry on its surface, smooth, and glistening; its internal texture resembles that of tendon; and it acquires something of the appearance of the corium, or of a regenerated, or cicatrix, tissue.

b. The second change of texture affects the inner coat of the excretory ducts and reservoirs of glands, and of other hollow organs which are lined with mucous membrane: and the condition under which it occurs is that of some contraction or closure of the orifice, in consequence of which the secretion of the gland, or of the mucous membrane itself, accumulates, and gradually distends the cavity beyond its normal dimensions. It is observed in the gall-bladder, in the Fallopian tubes, and even in the uterus, in the excretory apparatus of the kidneys, and in the appendix vermiformis of the cæcum. This change of texture consists in a slow atrophy of the mucous membrane, and gradual condensation of the submucous cellular tissue to a serous layer, which at last takes the place of the mucous membrane. The tissue being changed, of course the secretion also is gradually altered; and instead of mucus, a fluid like synovia, and afterwards a thin serum, are secreted. This condition bears generally the name of dropsy of the respective organs,—dropsy of the gall-bladder, of the Fallopian tubes, of the uterus, &c.,—*dropsy of the excretory ducts of glands*. The membrane which usurps the place of the mucous structure is thenceforward subject to the diseases of serous membranes in general; and some of them are remarkable as not occurring to normal mucous membrane, or to submucous cellular tissue; such for instance as ossification.

9. *Adventitious formations*.—Strictly speaking, very few adventitious growths are developed in and from the parenchyma of mucous membranes themselves: for, with the exception of teleangiectasis, tubercle, and cancer, and of these, indeed, only particular conditions and forms, almost all the new growths belong to the submucous cellular tissue. But as that tissue is intimately connected with the mucous membrane over it, so are also the new growths that originate and spread in it. The mucous membrane becomes involved in various ways, as may be deduced from the following remarks.

There are, moreover, several other affections of the same class, to which mucous membranes are subject only after having undergone a previous change of texture.

a. Growths of horn and hair have, in a few cases, been seen upon different mucous membranes, particularly on the conjunctiva, the mucous membrane of the intestinal canal, and that of the urinary bladder.

b. Lipoma.—This growth is almost confined to the submucous cellular tissue of membranes near which a considerable quantity of fat is occasionally deposited. It is by no means rare in the submucous cellular tissue of the intestinal canal, especially of the small intestines; and it is met with also, but less frequently, in the stomach. It forms a rounded tumour, with a broad, or a somewhat constricted base; its size is mostly inconsiderable; it protrudes into the cavity, and is covered with the lining membrane, of the organ in which it is developed.

c. Cysts are formed in cellular or other submucous tissue, but they very rarely occur. They displace and stretch the mucous membrane, and, when of large size, even produce attenuation and atrophy of it.

d. Fibroid tissue occurs as—

a. An adventitious fibroid growth of various size in submucous tissues: as such it presents itself under two forms, the second of which, for several reasons, is of much importance.

One of these forms is that of spherical, oval, or subovate, bluish white, tough and elastic, concretions, the texture of which is very compact. It occurs in extensive tracts of submucous cellular tissue, particularly in the stomach and intestinal canal, and forms moveable tumours which protrude inwards: they are very seldom larger than a pea.

The other form is that which has been named fibrous, to distinguish it from the mucous or cellular, polypus; an adventitious growth of fibrous, and for the most part lax, texture, vascular, succulent, apt to swell, and generally more or less lobulated towards its periphery. It takes root by a single, or by several stems in submucous tissues of fibrous or muscular texture; it then grows towards the cavity of the organ, and thrusts before it a covering of mucous membrane. If it reach a large size, it expands the cavity on all sides; but if there be any hinderance to its increasing in the direction of the

cavity, it will grow principally in one direction, in either case destroying the walls of the cavity, even though they be of bone. Of this kind are the large fibroid growths, also named sarcomatous polypi, that spring from the submucous periosteum of the nares and adjoining cavities, from that of the basilar process of the occipital bone (the upper wall of the pharynx), from the perichondrium of the cartilages of the larynx, and from the innermost (submucous) layer of the substance of the uterus.

β. Fibroid tissue occurs also as fibroid and cartilaginiform thickening of the walls of mucous cavities which have been converted in the way already described into serous cavities: the fibroid tissue may then, as in the case of membranes originally serous, be deposited as an exudation, upon the surface of the new membrane, or as a subserous production, beneath it. Under the same conditions, that is to say, only after the mucous membrane has undergone this complete change of texture,—

e. Anomalous bone is formed upon it, or *ossification*, as it is called, takes place: and this again may be a subserous production, or an ossified exudation on the surface. Cavities of mucous membrane are in this manner sometimes converted into bony capsules; but the only instance in which I have observed it is the gall bladder.

f. New growths of cellular tissue, or condylomata, occur upon some mucous membranes, especially upon the female organs of generation, in the mouth, &c.

g. Teleangiectasis. Congenital vascular nævi are, on the whole, a rare occurrence in mucous membrane, especially if those be excepted which extend from the skin to adjoining mucous textures, as, for instance, from the skin of the face to the mucous membrane of the lip. When they do occur, it is usually in the form of bluish red, flattened or irregular, elevations of various sizes, and rarely in that of actual tumours or excrescences: they may be most frequently observed on the inner membrane of the intestinal canal.

h. Tubercle. Tuberculosis is one of the most frequent, and, at the same time, most destructive, diseases of mucous membranes: its frequency, however, is not the same in all of them. The devastations which it produces, too, though they vary considerably in their degree, are greater, on the whole, than

se which result from any other process upon mucous membranes. The tubercle is deposited in the parenchyma, *i. e.* in the corium of the membrane, and in the immediately adjoining stratum of submucous cellular tissue,—

a. Either gradually and at intervals, for the most part without any manifest congestion and stagnation, in the form of isolated or clustered, gray crude granulation ;

3. Or, with evident symptoms of inflammation, as an inflammatory product, infiltrated into the parenchyma of the membrane, and partly also exuded upon its free surface. The duct, in this case, either has from the first the character of a yellow tubercle about to soften ; or it becomes rapidly discoloured, and soon acquires that character. Large tracts of the mucous membrane degenerate into a lardaceo-caseous and firm, friable, layer, and the submucous tissues become dense, opaque, and thickened. Acute tuberculosis, in the form of extremely fine, transparent, and crystalline, or of opaque, wheylike granulation, seems not to occur on mucous membranes, at least, not in the marked degree in which it prevails on serous membranes, and in certain parenchymatous organs.

Precisely the same forms of tuberculosis seem to occur in the follicle, and glandular apparatus peculiar to certain mucous membranes, such as those of the mucous membrane of the bowel.

Of the several large sections of the mucous system, the most frequently diseased is the intestinal tract : next come the air passages, and after them the lining membrane of the sexual organs of the female, the seminal ducts of the male, and the urinary passages in both sexes. And it is chiefly certain parts of these membranes that are subject to the disease, as will appear in the consideration of the diseases of the several organs ; for there are some parts which rarely, and others that never, become tuberculous. Those to which the former observation applies are certain portions of several mucous membranes, which, in the abundance of their glandular apparatus, approximate to the character of so-called parenchymatous organs : but still there are remarkable exceptions to this rule. Thus, in the intestinal mucous membrane, the disease occurs chiefly in the ileum, which has an extensive follicular apparatus, and in the follicles themselves ; and, in the mucous membrane

of the air passages, principally at the posterior wall of the larynx, which is so rich in glands: in the sexual organs of the female, on the other hand, the cervix and vaginal portion of the uterus, and the vagina itself, all which are richly supplied with follicles, are exempt from tuberculous disease; the glandular mucous membrane of the stomach is rarely the seat of it, &c.

Tuberculosis of mucous membranes is sometimes a primary disease, as is the case particularly when it occurs on the inner coat of the fallopian tubes and uterus; but far more frequently it is a secondary and dependent affection, occasioned by previous, and for the most part advanced, tuberculosis of some parenchyma which stands in close relation with the diseased membrane, or of some generally important parenchymatous organ, such, for instance, and, above all, as the lungs.

This condition of tubercles in mucous membrane, viz. their originating from a considerable amount of constitutional disease, which is already manifested by an advanced tuberculous affection of a parenchymatous organ, is the reason why tubercle in that membrane undergoes scarcely any other metamorphosis than that of softening, and gives rise to tubercular phthisis of the membrane.

The *gray granular tubercle* softens in the substance of the mucous membrane, and forms a small vomica. Opening on the free surface of the membrane, the vomica becomes a small circular ulcer, the margin of which is sometimes flabby, but usually is hard and prominent: its base is composed of a stratum of mucous membrane, or of submucous cellular tissue; and it also may be soft and lax, but it is usually callous and condensed.

This *primary minute tubercular ulcer* enlarges superficially as well as in depth, by coalescing with neighbouring ulcers, and by the softening of tubercles which have been deposited secondarily, during its progress, at its border and base. It thus exchanges its original form for a secondary and still more characteristic one; for it acquires sinuous, serrated, jagged, and gelatino-lardaceous borders, and a dense callous base, beset with islands and far-jutting promontories of mucous membrane; while the tissue of the base, as well as of the borders, appears interwoven with tubercles, for the most part yellow and softening.

The *tuberculous infiltration* of mucous membrane burrows in different directions, and becoming caseo-purulent, degenerates, together with the tissue which it involves, and which has lost its characteristic structure, to a tubercular sanious matter.

From the mucous membrane, and especially from the base of the tubercular ulcer, the deposition of tubercle advances into the different submucous tissues, and gives rise to a destructive ulceration that in membranous canals and cavities leads to perforation.

The tubercular ulcer of mucous membrane very rarely heals, as may be supposed from what has been said. When it does so, it always leaves at its borders, and still more in the structures that formed its base, a permanent callous condensation, corresponding to the original size of the ulcer. But for an account of this, and of several essential peculiarities which tubercle and the tubercular ulcer present on different mucous membranes, I must refer to the description of the diseases of particular mucous organs.

i. Cancers.—Mucous membranes are very subject to cancerous affections; some are more frequently diseased than others, and especially the mucous lining of the whole alimentary tube. It would, however, be erroneous to regard every such affection as a primary affection of the mucous membrane; for in the majority of cases, the cancer originates in the subjacent cellular tissue, and the mucous membrane is diseased secondarily and by contiguity.

Although any of the various cancerous growths may occur in mucous and submucous tissues, yet, so far as I am aware, nothing definite, nothing supported by numerous observations, can be brought forward to prove the occurrence of cancer primarily in mucous membrane, or to show the condition of that membrane when the cancerous growth appears originally in the submucous tissue, except in the cases of areolar, medullary, and fibrous cancers.

The areolar and the medullary are the forms of cancer in which primary cancerous degeneration occurs in the tissue of the mucous membrane. They are rather frequent.

The areolar is known by its characteristic degeneration: it extends, for the most part, over large tracts of mucous membrane, especially in the stomach and intestinal canal.

The medullary presents itself,—

a. Sometimes as nodules, which are of a round, or slightly convex form, or which even produce a navel-like depression on the free surface of the mucous membrane: they are situated in its parenchyma, but project more or less above its free surface; and they have a lardaceous, or medullary (encephaloid) appearance. Cancer of the mucous membrane in this form is scarcely ever the primary cancer in the system, but is almost always a consecutive affection, combined with some previous cancerous disease of the adjoining submucous tissues.

β. Another form of cancer which occurs more frequently, and particularly on certain mucous membranes, is looked upon most properly as a kind of medullary cancer. When in an advanced state, it forms more or less extensive spherical tumours (fungi), which are attached by a constricted neck-like base, or even what might, with reference to their bulk, be named a pedicle. They take root in the parenchyma of the mucous membrane and the immediately adjoining cellular tissue. They are for the most part loose, very vascular, abundantly supplied with blood, and of a bluish-red colour; and they readily swell, and bleed frequently and severely. They are composed of a delicate membranous texture, that sometimes breaks down into fibres, sometimes into laminae, and is filled with a whitish or whitish-red marrow, or a similar encephaloid juice. In many cases, the mucous membrane is affected in this manner at some one circumscribed spot; in other cases the growths spring up on a membrane in the form of smaller excrescences which are attached by a pedicle, and at their free extremities are shreddy and grow like a cauliflower, and are clustered so closely together, that the whole tract of membrane which they occupy seems to be degenerated into them. Their elementary texture, and their development from their mother-soil, has been already described, and a special form has been mentioned as an epithelial fungus. I have also shown their alliance with the cauliflower excrescences that occur on anomalous serous membranes, *i. e.* on the inner surface of cystoid growths; and, lastly, have mentioned, that they no doubt constitute for the most part the erectile cancerous tumours, as they have been called, particularly by French observers.

They are often found in the mucous membrane of the stomach and intestinal canal; but they are particularly frequent within the urinary bladder. Frequently, and indeed generally, they constitute the primary cancer, that is to say, that which first appears in the organism; and they continue the only one, until by their sanious discharge and hemorrhage, they prove fatal.

Mucous membrane is always affected by fibrous cancer secondarily, being destroyed by the advance of that growth from the submucous tissues. The mucous membrane may be in various conditions: of these some have been described already, and others will be mentioned in the account of the particular organs in which they occur; but there is one character which may be spoken of in this place, which it shares with other structures that become involved by contiguity in cancerous diseases, and more particularly with the skin, namely, that when encroached upon by a mass of cancer, mucous membrane becomes adherent to it, united with it, and at length entirely lost in it.

PART VII.

ANOMALIES AND DISEASES OF THE SKIN.

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§ 1. *Defect and Excess in Development.*—Congenital deficiency of the integuments is extremely rare, whether extending over the whole, or only over parts of the body. An instance of the former kind was observed by Bartholin; and Cordon met with a case in which the skin was wanting from the knees to the toes.

Upon the skin of new-born children there are often seen circumscribed spots, the complete development of which has been arrested by some pressure during foetal life. It is uncommonly thin and transparent, and its defect appears proportioned to the closeness of its union with the fibrous and serous membranes beneath it. Instances of this deficiency are seen in hemicephalus, in spina bifida, and in several of the fissions of the anterior wall of the trunk. A congenital defect of another kind has also been met with, in which the general sac of the integuments is so small at particular spots as, according to an observation of Otto's on the lower extremities of new-born children, to form strictures.

An acquired partial deficiency of skin is produced by wounds, burns, suppuration, sloughing, and other causes from which losses of substance ensue.

A preternatural growth of skin may occur as a congenital condition and produce an increase in the capacity of the general sac. The additional skin is loose and moveable, and hangs in folds and appendages; thus at the end of the spine it forms a sort of tail. Instances of an acquired excessive growth of skin are furnished by several of the encysted tumours: they usually present here and there spots that resemble cutis; and they are the tumours in which the hair that grows in cysts is chiefly found.

The same class includes all cases of regeneration of skin, whether destroyed by wounds, burns, or cauterization, by the various ulcerative processes, or by mortification. The loss is in general easily repaired, but always in a form that differs more or less from the original skin. The new structure consists of a dense cellular layer of various thickness, and of epidermis; but it has neither papillæ, sebaceous glands, hair follicles, nor sudoriparous glands. It is usually tightly stretched and whiter than natural: sometimes it is smooth and shining, sometimes it has a rugged and uneven, stellate, knitted, or areolar surface: very often it is but slightly moveable over the subjacent structures, and occasionally is intimately united with them. It lies beneath the level of the surface of the rest of the skin.

§ 2. *Anomalies in the Size (capacity), the Thickness, and the Form of the Sac of general Integuments.*—In regard to size, the congenital anomalies already mentioned belong also to this section. Further instances of acquired anomaly in this respect are found, on the one hand, in the contractions, shortenings, &c. which result from various losses of substance and the cicatrization consequent upon them; and on the other hand, in the dilatations to various amounts, which are produced, for the most part, by gradual distension or traction. Moreover loose, or soft and elastic, pendulous growths of various sizes are formed upon the skin: within an attenuated corium they inclose a delicate cellular tissue, most of which is newly formed (*molluscum simplex*), and occasionally they contain also some adipose tissue, which has protruded through the meshes of the deeper layer of the corium.

The form of the cutaneous sac is disfigured not in these cases only, but also in a more or less striking manner when there exist, or have existed, many diseases of its texture.

The skin deviates from its natural thickness in both directions.

An abnormal *thickness* is sometimes occasioned by congestion or inflammation of the skin, and attended with expansion and moistness of its texture: sometimes it is the result of a continuance or repetition of the same processes, in which case the deposition of their plastic product in the tissue of the skin

adds condensation of texture and firmness to the increase of its thickness: sometimes the cause is hypertrophy, which again may chiefly affect the papillæ or the deeper layer of corium: and, lastly, it is sometimes the effect of the development of adventitious growths in the corium.

Hypertrophy of the skin is in many nævi a congenital affection; but more frequently it is extended over wide tracts of skin, and is a result either of stagnation in the venous or lymphatic system, or of habitual inflammatory processes, particularly those of exanthematous and impetiginous nature. It accompanies, on the one hand, under the name of elephantiasis (*Pachydermia* of Fuchs), exuberant growths—hypertrophies—of the subcutaneous cellular tissue; and on the other hand, most probably all, but particularly the more important, anomalies of the secretion of epidermis.

The form it presents is very various. Sometimes the hypertrophied portion of skin is smooth, sometimes the irregularity of the hypertrophy renders the surface rugged and tuberous: the skin may be moveable over the subjacent structures, but in advanced degrees of the disease it is stiff and adherent, especially to fibrous structures; and the diseased part, the leg for instance, then becomes immovable; its muscles, and even its bones shrink, and the articular extremities of the latter become ankylosed.

The papillæ become hypertrophied in various degrees and forms: sometimes they resemble the villi of the intestines; sometimes they constitute excrescences which are attached by a pedicle, and truncated, or split like a tassel at their free extremity, or are sessile, rounded, and like a mushroom, &c. Hypertrophy in these forms is seen on nævi, and on portions of skin which have long been withdrawn from the atmospheric influence, and exposed to that of warmth and moisture, or have been covered with emollient and slightly irritating plasters, &c. It is noticed also in parts at which the skin has been in contact for a lengthened period with its own secretion, as it is in the deep fissures between the rolls and knots of skin in cases of elephantiasis; in the neighbourhood of chronic ulcers; and on spots of skin covered with scaly eruptions: the hypertrophy of the papillæ is very marked also in decided cases of ichthyosis. Lastly, it is found,—at least it is assumed as pro-

bable,—that the genuine common wart (*Verruca vulgaris*) is a hypertrophy of the papilla beneath a very thick layer of epidermis, which dips in sheath-like processes into the deeper parts of the growth. Warts are exceedingly common upon the hand, especially on the fingers; occasionally too they occur in other parts, as, for instance, on the forearm.

The skin may yield to distension or traction from within, and become unnaturally *thin*. Instances of this are met with in cases of dropsy of very dilatable serous sacs, of the peritoneum, for instance, or the tunica vaginalis testis; in anasarca; or when large tumours are growing in the subcutaneous cellular tissue. The fasciculi of fibres that compose its deeper layers separate from one another, its exterior dense stratum becomes so thin as to be transparent, and even at last to suffer gradually a solution of continuity. In the fœtus, under these circumstances, it assumes the character of a serous or fibro-serous membrane, and uniting intimately with the subjacent membranous structures, appears, as was before said, to be deficient at such spots.

When long continued pressure is exerted upon one fixed spot of skin, such, for instance, as is produced by a tumour, complete atrophy sometimes takes place: the skin is gradually reduced to a thin vascular stratum, which secretes a viscid epidermal mucus, and at length is completely perforated.

Primary atrophy of the general integuments, strictly speaking, does not occur; but they become atrophied rather frequently as a secondary consequence of repeated attacks of inflammation, especially those of impetiginous character. The skin becomes thin and vascular, acquires a dirty brownish or bluish colour, and generally gives way upon very slight injury; at last it changes into a dense white cicatrix tissue.

§ 3. *Anomalies in Consistence*.—Laxity of the corium exists congenitally in cases of nævus; and congestion or inflammation will, after birth, bring on a state in which the texture of the skin is loosened or expanded. It becomes loose also in parts which are withdrawn from the air, and continually exposed to moisture; in parts where perspiration is constantly taking place, and in the hands of little children, who have a habit of sucking them, &c. But, again, cutaneous tissue is sometimes increased

in density and hardened; it becomes hypertrophied and thickened, or without being thickened, it may be hypertrophied, dry, and harsh.

A certain amount of softness of the skin, as well as of hardness and dryness, is sometimes merely an individual peculiarity of the whole organ.

§ 4. *Solution of Continuity.*—The general integuments are, in the first place, liable to very numerous and very varied mechanical injuries: solutions of continuity may also be produced in different ways by the action of chemical agents upon the skin; and, lastly, the same result ensues from the many ulcerative processes that take place in this structure. We must, however, notice the various forms of separation of the epidermis from the corium (spontaneous excoriations), that are occasioned and kept up by diseases of the skin, the spontaneous lacerations already alluded to, that are produced by extreme distension, and the fissures extending into the corium, which, in many chronic diseases, proceed from the splitting of an extremely dry epidermis (chaps—Rhagades). They heal in the usual manner, either by immediate cohesion of the lips of the wound, or by granulation and cicatrization.

§ 5. *Anomalies in Colour.*—The deviations from the natural colour of the integuments are very numerous. They are, in general, either an absence of colour or pallor; or a deepening of it; or with one or other of these may be combined a discoloration. Sometimes they are universal, at other times they are confined to larger or smaller tracts, or even to points, of the skin, in which case they are often almost peculiar to particular regions of the body. Their site may be the cutis vera, and their principal cause an anomaly in the quantity of blood circulating in its vessels, or rather a transient or permanent alteration in the constitution of the blood; or they may be situated in the epidermis, especially in the innermost—the Malpighian—layer of it, and may proceed either from the removal of the fibrin from the elementary cells of which the layer is composed, or from their containing an excess of fibrin, or some unusual pigment. Their cause is, in some cases, an anomaly in the constitution of the blood, in others it is some

external influence affecting the skin during life : but in neither case is the mode in which the cause operates fully understood.

Lastly, all diseases of the texture of the skin are, of course, attended and followed by changes of its colour.

Pallor, or change of the colour to a variously tinted *white*, is observed during the lack of blood that succeeds hemorrhage and exhausting diseases ; it occurs in dropsy, and in a very marked degree in cases of chlorosis. In Albinoes (*Leucæthiopia*) it is the result of a congenital deficiency of pigment, while in *Achroma*, the same defect is acquired. The latter condition may be seen in Negroes, and indeed in Europeans, wherever the surface is naturally dark coloured ; as, for instance, at the parts of generation in either sex, where it appears in the form of white spots of various size, that gradually spread, and at last, in some few cases, amount to a general discolouring.

Yellow, either pure or mixed with green, is the well known colour in cases of icterus. A similar hue, but inclining to brown, arises from the deposit of pigment in the epidermis, either in small stains, or in large discoloured tracts, or even over the whole surface of the body : the cause of this deposit is still partly obscure. The uniform embrowning of the skin, brought on in parts that are exposed especially to the light of the sun, is of this kind also ; as well as the spotted stains or summer freckles (*ephelis*) ; and the liver spots (*chloasma*) which depend upon anomalies in the biliary system, and in the sexual system of the female. The colour of the skin generally becomes dark, when with neglect of it and indulgence in alcohol are combined infiltration of the liver with fat, and a tallowy state of the adipose substance, particularly of the subcutaneous layer of fat. The skin, in the last case, feels fatty, soft and velvety, like that of a negro ; its colour proceeds from the deposition of a pigment containing fat in the deepest layer of the epidermis, — a fact of particular interest, on account of the combination, just mentioned, in which it stands.

Red colouring of the skin appears in extremely numerous forms, and with various shades of yellowish, bluish, livid, coppery, brown, and so on, which are well known as pathognomonic of various diseases. It occurs in cases of mere congestion, in inflammation, in exanthematous and impetiginous

processes, in teleangiectasis, and many of the diseases of the texture of the skin. The redness inclines to blue, and even to black, in hemorrhages into the cutaneous tissue, or upon its surface, in sugillations, ecchymosis, vibices, petechiæ, &c.

In cases of cyanosis there is a general bluish or *blue* colour of the integuments; but it is principally marked in situations where the skin is delicate and highly vascular, and in the extremities. The blue tint, when limited to certain spots, is a result of local congestion. A transient blueness of the skin has also been noticed, in a few cases, at various parts of the surface, but its internal cause is unknown. (Otto.)

Spots (*livores*) of a bluish-red, a livid, or a blackish-blue colour, appear upon the body soon after death.

Various shades of *bronze* are produced upon the skin by the long-continued use of nitrate of silver: they sometimes gradually disappear, but occasionally they remain permanently. No evidence has yet been obtained as to the seat of this discolouring: it appears first, and has its deepest hue, on parts of the body which are exposed to light.

A *black* colour is observed principally in old cachectic persons, in whom it is sometimes diffuse and extends over large tracts of skin, especially in the lower limbs, and sometimes appears in the form of black nodules, which are deposited chiefly on the face. It has in a few cases been seen gradually spreading over the whole body. It is named *melasma*, and is a different affection from cancer melanodes of the skin.

Almost all these discolourings occur also, as congenital and partial appearances, in the various *nævi*.

A *tawny* colour, a *dirty gray*, a *dirty bluish*, a *lead*en hue is by far the most frequent of all the changes in the colour of the skin: it is an expression of dyscrasia, and of faulty chymification, and is found in the course of acute and chronic diseases.

§ 6. *Anomalies of Texture.*

1. *Congestion*, — *hemorrhage*, — *anæmia*. — A passive congestion, limited to certain parts of the skin, may be constantly observed on the dead body. It is seen, too, on the whole integuments, as a dark redness, with a blue or black tint, in the course of acute and chronic adynamic diseases, and in most instances of agony: it is very marked in parts of the body that

are at a distance from the heart, and becomes extremely so if there be any mechanical interruption of the circulation.

Congestion in a higher degree gives rise to hemorrhage into the tissue of the skin; sometimes in small circumscribed spots, sometimes in streaks, and sometimes to a large extent: it may take place upon the surface of the corium beneath the epidermis, or in the tissue of the former; and, in the latter case, it is usually associated with hemorrhage into the subcutaneous tissue also. The bloody spots in Werlhof's *morbus maculosus*¹ and in scurvy, the petechiæ in the course of typhus and typhoid fevers, &c. are instances of such hemorrhage. Its occurrence is facilitated by delicacy and susceptibility to injury on the part of the walls of the capillary vessels, and by a tendency to transudation on the part of the blood.

Anæmia of the general integuments is a local part of an universal anæmia, and is always accompanied with collapse and pallor of the skin: the pallor acquires a waxen character when the skin is delicate, and especially if at the same time it be rendered tense by the presence of fat or œdema.

2. *Inflammations*.—Inflammation of the skin (dermatitis) may result from very various external influences, which are but partly known, and be an idiopathic, substantive disease: it also very frequently occurs as a symptomatic and dependent affection,—a reflex of other morbid processes. Regarded in an anatomical point of view, it is found sometimes diffuse, and extending over large tracts of skin; sometimes it is circumscribed, and confined to one or more small spots.

In the first form, the true cutis is the part attacked, and sometimes only its external layer and papillæ—*erythema*: at other times the deeper layer also, that is to say, the whole thickness of corium is affected; and that constitutes *phlegmonous* inflammation.

From it, and particularly from the erythematous form, there are several transitions to the *circumscribed* inflammation of skin. The simplest form of the circumscribed is *furuncular* inflammation.

Allied to this are several of the acute and chronic exanthematous processes.

I proceed now to speak of them in detail.

[¹ *Vide* Behrens' *Dissert. Epistol. de Affectionibus a Comestis Mytilis*, Hanover, 1735, p. 3.—Ed.]

a. Erythematous inflammation of skin.—Erythematous inflammation, as has been said, is an inflammation of the outermost layer of skin, which contains the papillæ; and it includes not only the slight inflammation produced by external agents, such as the heat of the sun, fire, cold, irritating plasters, trifling injuries, the stings of insects, &c., but also spontaneous inflammations of exanthematous nature, which are essentially connected with other morbid processes, such as the various erythemata, erysipelas, scarlatina, measles, intertrigo, &c.

Erythematous inflammations usually run an acute course, but several of them are apt to recur, and to become habitual.

The following are the anatomical characters of the disease. The redness is for the most part bright and uniform, but sometimes it is irregular, presenting here and there various forms and outlines of a deeper hue, and very frequently it has a shade of yellow: the colour gradually diminishes towards the border of the inflammation, and passes imperceptibly into that of health: it disappears upon pressure, and quickly returns when the pressure is remitted. There is mostly but trifling swelling, such as can be perceived only by the touch, and at the border of the diseased spot. The exudation is determined by the intensity of the process: sometimes there is none; sometimes a watery fluid, effused slowly or very rapidly, raises the epidermis in small and scattered, or in confluent, vesicles. The under surface of the skin is reddened, has a granular or uneven glandlike appearance, and is covered more or less distinctly with a grayish white, soft, gelatinous, plastic exudation, which is sometimes perforated and cribriform, and sometimes is reticulated on the surface next the skin. If the inflammation still increase after this product is deposited, the redness becomes darker, and the exudation reddish, milky, and at last purulent.

After death the redness has generally disappeared, but the swelling is still perceptible; the epidermis is either easily separable or actually separated, and the surface of the cutis is moist, and covered with a viscid and more or less puriform exudation. The redness is seen on a transverse section to be confined to the outermost thin layer of the cutis; the deeper layer is pale, and is somewhat infiltrated only when the inflammation is intense: the subcutaneous cellular tissue is then in like manner slightly infiltrated.

Erythematous inflammation generally terminates by resolution, the epidermis peeling off one or more times, according to the severity of the inflammation, in the form of a mealy powder, or a bran-like scurf, or of larger scales and laminae, until the skin, covered with a new thin epidermis, looks smooth and shining and of its healthy colour.

b. Phlegmonous inflammation of skin. (True dermatitis).—Phlegmonous inflammation extends beyond the papillae into the deeper strata of the corium, and sometimes involves not only the entire thickness of that part, but also more or less of the subcutaneous cellular and adipose tissue. It arises very often from the contact of powerful external applications, like burning or cauterizing bodies, with the skin; and sometimes, without manifest external occasion, from an internal cause: sometimes, again, it is produced by the extension of inflammation from subjacent structures, from cellular tissue, muscles, veins, or absorbents.

Just as, under certain circumstances, the phlegmonous arises out of the erythematous inflammation, so also has it several degrees of its own, which pass imperceptibly into one another. Its course is in most cases acute, but it is often chronic, and then usually becomes acute from time to time.

The following are the anatomical characters of *acute* phlegmon of the skin. The redness of the inflamed spot is generally deep (saturated) and dark, it varies in its tint according to the state of the blood, and does not disappear upon pressure: the swelling is moderate, but the firmness of the skin amounts to decided hardness: the tissue of the cutis is found upon section to be red, and to have a homogeneous fleshy appearance; its reticular structure has disappeared; the fat contained in it has lost its characters; and it is also easily torn: the subcutaneous cellular and adipose tissue is minutely injected, and infiltrated with a serous fluid. The under surface of the skin presents more or less redness, and a shreddy, granular appearance, and is covered with a viscid exudation, that as it softens becomes purulent.

Chronic phlegmonous inflammation of the skin, such as is developed gradually out of repeated attacks of erythema, and is kept up by various constitutional affections that arise from the suppression of normal or of anomalous excretions, presents very

different characters according to the degree of the inflammation, and the circumstances by which it is occasioned and maintained.

The redness is usually dull, and inclines to a bluish, brown, or bronze colour.

The tumefaction of the cutis itself is slight: its density is sometimes increased, sometimes decidedly diminished; and it is accordingly firmer than natural, or loosened in texture, and spongy.

The cutis when exposed is sometimes found smooth, uniformly softened and spongy, sometimes it is unevenly granular, and either soft or rather hard. It is covered with a limpid, watery, and colourless, or with a yellowish, yellowish red, and bloody, or with a thick, viscous, clear or turbid, and yellowish white, or a yellow purulent, moisture: these products soon change to dirty white, asbestos-like, epidermal scales, and then peel off; or, becoming thickened and dried, form a covering like various kinds of bark.

The subcutaneous cellular tissue is sometimes infiltrated with a viscid serous fluid, and injected; sometimes it is denser than natural, hard and lardaceous, &c.: as the fat disappears, the inflamed spot is depressed beneath the surface of the adjoining healthy skin.

This inflammation terminates in various ways.

Acute phlegmonous inflammation sometimes terminates in *resolution*, but it leaves the diseased part of a bluish-red colour, very susceptible of external influences, and liable to a recurrence of the inflammation for a long time afterwards. It often gives rise to destructive *suppuration* of the superficial layer, or of the whole thickness, of the corium. That coat is then replaced by a cicatrix, which becomes more or less fixed to, and blended with, the subjacent structures: if inflamed and suppurating surfaces of skin be brought into mutual close contact, they may even unite with one another.

Extensive phlegmonous inflammations and suppurations of the skin, particularly those which are produced by burns and scalds, very often lead to a fatal result, either speedily by *exhaustion* of the vital powers during the violence of the fever, or more slowly by their drain upon the blood, by congestions, inflammations of internal organs, especially of the lungs (hypos-

tasis), or by exhaustive serous exudations, particularly on the mucous membrane of the intestines. Burns, and especially, as I have observed, burns of the skin of the abdomen, are in a few instances attended by fatal hemorrhage from the bowels, which is most probably introduced by an exudative process.

Now and then, acute phlegmonous inflammation of the skin terminates in *mortification*: but of this hereafter.

The consequences of chronic cutaneous phlegmon do not cease with the permanent anomalies to which it gives rise in the stratum beneath; these are in themselves of a serious character, but they obtain greater importance from their relation to the integrity of the whole organism. At one time it leaves behind it a *condensation* and *thickening* of the skin, in which the subcutaneous cellular tissue also is generally involved,—hypertrophy with induration, and adhesion of the skin to the subjacent structures.

Under certain etiological circumstances, the inflamed spot becomes a vicarious organ of secretion. The exposed skin, having thrown out a few granulations, secretes a thin fluid, which is often very acrid and corrosive, and gradually eats away the substance of the cutis. If at length, the conditions being favorable, the secretion should subside, and the part heal, the cutis is replaced by a dirty brown, vascular, very vulnerable and frail stratum, which, for the most part, produces large scales of epidermis in considerable quantity, and is very long in turning pale, and in acquiring the firmness of a sound cicatrix tissue. The whole metamorphosis is a secondary *atrophy* of the cutis occasioned by the inflammation.

Chronic inflammation of the skin frequently ends in *ulceration*: and especially is this the case when, from some internal or external cause, the chronic is rapidly exaggerated to a more intense degree of inflammation, or when inflammation returns at a part where the change into cicatrix tissue is going on. Suppurative and sanious destruction, in various forms and to different extents, that is to say, ulcers, then ensue with more or less rapidity.

It may happen that several of these terminations of inflammation exist near together, or are associated with a continuance of the inflammation.

c. Furuncular Inflammation.—The forms in which this kind

of inflammation occurs are furuncle and anthrax: it occupies the deeper, areolar layer of the corium, and the cellular tissue filling the interspaces of its network. A circumscribed swelling at first presents itself, no larger than a hempseed or a pea, which, as it gradually increases in size, becomes remarkable for the (reactionary) inflammation that attends it: for the inflammation forms proportionally a wide halo around the swelling, corresponding with the pain and the marked degree of tension that exist; it reaches also into the deeper structures, and fixes the swelling of the skin to the subcutaneous cellular tissue. Before reaching its highest point of severity, it furnishes a product that is known by the name of a (Pfropf), *core* or *plug*. This product has been regarded as sloughy cellular tissue; but, upon more thorough examination, it is found to be a product of the inflammation going on in the cellular tissue contained in the meshes of the corium, and to resemble false membrane,—to be, therefore, exudation. It occupies the whole thickness of the corium, and exists there before the swelling is very perceptible: at first, it is closely connected with the surrounding injected tissue, but, as the (reactionary) inflammation around it produces suppuration, it is thrown out. The core has in fact nothing in common with separated sloughy cellular tissue, it is exudation; though it certainly may contain a few fibres of cellular tissue interwoven with it, which have been severed from the rest by the suppuration going on around it. (Gendrin, Aschersohn.)

In furuncle only one such product is formed; in anthrax there are several of them near together. The reactionary inflammation around and beneath is very considerable, corresponding in degree to the pain and the feeling of tension. If before the commencement of suppuration, and consequently before the loosening of the cores, an incision be made into an anthrax, an uniformly red, spongy, or reticular tissue is exposed, the meshes of which are filled with cores. At a later period, when the cores are loosened from the inflamed tissue, and suppuration is just coming on, each core is found surrounded by a substance like jelly. When, at length, suppuration is established, the cores become completely separated, and, by the destruction of the meshes of the network, cavities of different sizes are formed, in which they freely swim.

Instead of leading to the production of matter, and suppurative destruction of the tissues, the process sometimes terminates in another way: for, under a combination of excessive local tension, and unfavorable general circumstances, viz., in the condition of the individual, and in external influences, mortification takes place, especially in the skin covering the carbuncle.

Furuncle very rarely terminates in induration; it might, when such is the case, be confounded with several other circumscribed nodular inflammations of the skin.

There are various other inflammations of the skin allied to furuncle, but differing from it: some are primary, others secondary, (or, as they are called, metastatic, critical.) Some are parenchymatous, others proceed from particular parts of the structure of the skin, especially from the sebaceous glands. They may terminate in suppuration or in induration.

d. Exanthematous Inflammations.—To this class belong all acute and chronic exanthematous processes which present the following general characters. They are preceded or accompanied by symptoms of inflammation: either at one spot, or at several, separate or clustered, points, they furnish a product: sometimes that product takes the form of vesicles and bullæ, and lies between the cuticle and cutis; sometimes it occupies the parenchyma of the cutis, being effused amongst the papillæ, or in the deeper layer, and forming nodules that either subside again, or suppurate and produce small abscesses or pustules; and sometimes, lastly, it gives rise to induration of the skin, to nodules and nodular thickening of the subcutaneous cellular tissue, and their usual consequences, suppuration, ulceration, or hardening.

The present appears to be the most convenient opportunity for alluding to these processes; for anatomy has not yet furnished satisfactory evidence as to their real site, whether it be the different glandular organs of the skin and their ducts or not. I venture, however, to omit giving any minute description of them, not for this reason merely, but also because we possess only a few fragments of anatomical information respecting their products; and further because the changes in the internal organs, which have hitherto been ob-

served after death,—changes, that is, essentially connected with the disease of the skin, and constant in their occurrence in many of these cases, though not, indeed, in all of them,—do not furnish facts in sufficient number and of a kind to allow of our constructing an account of their pathological anatomy, that would make any pretensions to truth and to practical utility.

The last remark applies particularly to those exanthematous diseases which are usually treated of amongst chronic diseases of the skin, for several of those which are now under consideration, as well as of the acute processes spoken of under the head of erythematous inflammations, are frequently fatal, and consequently become the subjects of pathological examination, especially true variola and scarlatina.

Although much has already been said, and some remains still to be said on the subject, it will be proper to mention here, in general, some of the principal results of examinations of the body in the cases of exanthema, that have been mentioned.

With an exanthema upon the skin that is discoloured, collapsed, and sometimes scarcely perceptible, are connected erythemata and exudative and pustular inflammations upon the several mucous membranes adjoining the external integuments. They take place especially on that of the mouth, pharynx, trachea, and bronchi, as well also as that of the urethra and vagina: they are complementary to the cutaneous eruption, and may be more or less substantive in their character; but frequently they are extremely developed both in extent and in the degree of their intensity.

Next in order may be placed the more or less palpable developments of the follicles of the intestines, especially those of the ileum: after these, similar developments of the mesenteric glands: and then congestions and enlargements of the spleen.

These may be followed by congestions of the central organ of the nervous system, and of its membranous investments; and very commonly, too, by increased density of the cerebral substance, with the exception of cases to be mentioned afterwards.

And next may be mentioned exudative processes upon mucous and serous membranes, especially on the former: some of these are genuine croupy exudations on the divisions of the mucous

system above mentioned, as croupy pneumonia, croup in the œsophagus, stomach, and intestines; others are gelatinous, purulent or serous exudations, and are found particularly on the mucous membrane of the bowel, and in the parenchyma of the lungs,—pulmonary œdema; others, again, are exudations upon serous membranes, especially upon the arachnoid, where they are accompanied with a turgid, moist, and loosened state of the cerebral substance,—œdema of the brain; some are met with on the pleura, &c., and even upon the internal surface of the vessels (phlebitis).

The acute black softening of the cardiac portion of the stomach, and of the œsophagus may be arranged next: and then

Gangrene on the general integuments and in the internal organs

Changes of the mass of the blood take place in the dead body parallel with these processes in the solids. The fibrin has a marked tendency to coagulate; the blood is deprived of its fibrin; or the latter is fluid; or the blood contains no coagulable part, but is either no thicker than water, or thick, viscid, like tar, and of a purple red colour, inclining to bluish, red, black, &c. With the changes last described, are connected marked collapse of the body, lividity of the integuments, (especially of the exanthematous part,) and of the muscles, and transudations into the serous cavities and into the tissues, and particularly the escape of blood into the parenchyma of membranous expansions, in the form of ecchymoses, petechiæ, effusions, &c., especially on the skin.

As the exanthematous, especially the acute exanthematous, processes are allied in their nature to the exudative, I must here refer to yet one septic exudative process which takes place upon skin deprived of its epidermis, and which is closely analogous to sloughing croup¹ (Bretonneau's Dyptheritis): it is that which is named hospital gangrene.

3. *Ulcerative processes.* The ulcerative processes are, for the most part, results of the inflammations already described; and they are especially liable to occur when those inflammations, having been raised to unusual intensity by some unfavorable external influences, either continue intense, or repeatedly become

[¹ Gangrenous stomatitis?—Ed.]

so ; or when they are called forth by some internal constitutional cause (dyscrasia) ; or when, running their course under such constitutional influence, they give rise to a special product by which the tissues are in a peculiar manner consumed (dissolved). As the inflammations, especially the various exanthematous forms of inflammation, present numerous characters which more or less distinctly manifest the nature of the constitutional affection, so also, and still more, are these characters usually stamped upon the ulcer.

Again, many ulcerations of the skin are produced by the metamorphosis of known adventitious growths in the skin itself or in the tissues beneath it ; others are secondary stages of various changes in the texture of the cutis, with which we are not as yet acquainted.

Of this kind the following are examples, though indeed most of them still require minuter anatomico-physical investigation : —all ulcers connected with disorder of normal, or what have become normal excretions : all those which originate in a congenital and hereditary, or in an acquired dyscrasia, whether the latter be simple, or combined and modified : all menstrual, hemorrhoidal, and urinary ulcers, as they are called, are therefore of this kind ; so also are the abdominal, the gouty, and the scorbutic ulcers, those which exist in psoriasis, the syphilitic and syphiloid, the leprous, scrofulous (tubercular) and cancerous, and the numerous cancrroid ulcers. They present many more or less characteristic differences in site and in form, *i. e.* in the state of their margins and bases, in their disposition to extend superficially or deeply, and in the amount, and especially in the quality, of their product : hence the known divisions of ulcers into round, oval, and sinuous ; into callous and fungous ; into moist and dry, &c.

As the ulcer presents various characteristic peculiarities, so also does the cicatrix.

It is important and interesting to observe the relation subsisting between inflamed and ulcerating integuments and certain subcutaneous structures, especially periosteum and bone : it is seen, for instance, on the cranium and shins, and prevails chiefly in the inflammation and ulcer arising from constitutional causes.

4. *Mortification of skin.*—Mortification is not an unfrequent occurrence in the skin : it arises from congestion and inflam-

nation, and takes place more readily the more insuperable the mechanical interruption to the circulation, and the greater the exhaustion of nervous power either in the system generally, or — a consequence of extreme severity of the inflammation or unfavourable external circumstances—in the part itself. Sometimes it takes the form of moist, sometimes of dry gangrene, —*sphacelus*—*cantharization*. In the former, the epidermis is raised in vesicles of various size, which are filled with a discoloured sanguino-serous fluid, and the tissue of the skin degenerates to a loose, pulpy, and offensively smelling mass of a brownish, brownish-green, or blackish colour: in the latter, the cutaneous tissue changes to a black, pretty firm, dry eschar, which is commonly pushed out with gas developed in the subcutaneous tissue, when they are affected with moist gangrene.

The *mortification* may extend from the skin to the subcutaneous tissue or vice versa, or again it may attack both *simultaneously*, however *heterogeneous*, together.

Examples of primary gangrene, as well as of the secondary *secondary form inflammation*, are furnished by gangrena senilis, by the *congested congestion* and gangrene that occur, often at *remote spots*, or *paralysed limbs*, by the sphacelus accompanying *typhus* and typhoid fevers, by bedsores, *ecthyma* *typhosa maligna*, *cancrem oris* (noma), by the *mortification* that takes place from various internal or external causes in *inflamed skin*, in ulcers, and in wounds, and by *accidental gangrene*.

Having seen two forms of mortification, a third is sometimes observed, which has been termed white gangrene (Mayo, *gangrena alba*). The skin becomes converted into a dirty yellowish mass, or grayish white, friable eschar. A similar form of *gangrene of cellular tissue* has been pointed out already, and a similar occurs on serous and mucous membranes. It may arise from the stretching—which is equivalent to compression of the tissue, or rather of the capillary vessels by an inflammatory swelling, or from the vessels being destroyed in necrosis of the subcutaneous cellular tissue (pseudoerysipelas).

5. *Adventitious growths*.—Here again I cannot avoid remarking that, whether from the apparent insignificance of these growths in themselves, or from the regard paid to that affection of the internal organs which gives occasion for the

examination of the body, the most accessible of them have received as yet but casual anatomical notice, and the distinctions between them have continued based upon their external characters only.

a. New growths of *cellular tissue* occur as :

a. Soft wartlike growths, attached by a pedicle, which constitute what is called the *Molluscum simplex* : the saccular dilatations of the corium are occupied by some cellular tissue at various stages of its development. They occasionally also contain fat.

β. *Fleshy excrescences* on the nose—exuberant or bottle-nose : these are composed of a luxuriant growth of corium and of cellular tissue.

γ. *Condylomata* are common about the organs of generation and the anus, especially on the mucous membrane of the former. Some of them are soft, others firm : in their form they may be broad or pointed : sometimes they are attached by a pedicle, and very often their extremities resemble a mulberry, a cauliflower, or a cock's comb. They are composed of an investing layer of epithelium and of newly formed cellular tissue ; and they originate in the corium, where their points, which, as is well known, are the more unmanageable part, take deep root (Simon). With these most probably we may connect those out-growing tumours which occur in the Pian of tropical climates, and have by many been regarded as syphiloid ; as well as various affections that are met with on the coasts of Europe, for instance, the Radesyge, &c.

b. *Fatty tumours* are usually congenital : sometimes only one exists ; at other times there are several, which are situated at different parts of the body. They form rounded, globular excrescences, which are, for the most part, truncated and attached by a pedicle, and sometimes grow to a considerable size. They consist of a prolongation of cutis, and inclose some fatty tissue, which seems like a protruded lobule of subcutaneous fat ; for at the base or neck of the excrescence it is continuous by a sort of pedicle with the general subcutaneous adipose stratum. The epidermis covering them is sometimes dark coloured, and contains pigment (*Nævus lipomatodes* of Walther), and unnatural hair often grows upon them. When it is a congenital disease, it is often associated with *nævus* in

other parts of the skin. In some few cases, these lipomatous growths are developed in later periods of life.

c. Fibroid tissue occurs in skin thickened by repeated, or by chronic, attacks of erythema; in the wheals and knolls of the skin in cases of elephantiasis, &c. It also constitutes cicatrix tissue.

d. The growth which Alibert has denominated *cheloid* may probably be placed in connexion with the last named; for it appears to consist of a fibroid callus, and with that appearance its external cicatrix-like aspect corresponds. There are several varieties of cheloid; it may be a simple hardness or callosity of the skin, either flat, somewhat raised, or depressed, and white or pale rosy-coloured; or it may be cord-like: in either case it frequently terminates in white or red elevated lines or processes (the *spider-like pimple* of Warren), and is of considerable extent. It occurs, for the most part, singly at the upper part of the trunk, on the extremities, or on the face; in very few instances does any large number exist.

It very rarely ulcerates; when it does so, the sore may now and then have a malignant (*bösartig*) character. Some constitutional disorder lies at the root of every case, but the nature of it is unknown; that it is cancerous is altogether problematical.

e. Anomalous bony substance is extremely rare in the skin. I once found, in the substance of a scar on the trunk an oval, yellowish, hard, rugged, osteoid plate, about the size of a thaler.¹ It corresponds precisely with the calcareous growths occurring in fibroid exudations upon serous membranes.

f. Teleangiectasis in skin is the well-known vascular nævus; it is almost always congenital. Sometimes it forms deep red, or bluish red, stains of extremely various size and form (*Feuermal*,—moles), and sometimes red tumours, which are shaped like cherries, strawberries, mulberries, &c., and are capable, more distinctly than the former kind, of a transient swelling, (*Dupuytren's* erectile tumours,—splenoid tumours of other authors.) But they do also commence in after-life, and in themselves are at first quite of a benignant, that is to say, not of a cancerous, nature. Nevertheless, if there be a cancerous

[¹ About the size of an English half-crown.—Ed.]

cachexia, the teleangiectasis may unquestionably become the seat of a cancerous growth; and, under such circumstances, it has been taken for a special form of cancer—*Fungus hæmatodes cutis*: it is not, however, an essential form of that disease, but is merely an accidental complication.

Teleangiectasis consists of a network of enlarged capillary vessels, imbedded in a delicate, and partly undeveloped cellular tissue.

g. Melasma, (benignant) melanosis includes both the black colouring which is observed, in some few cases, spread over the whole body, but more frequently limited to certain parts, especially the lower extremities; and also more particularly the accumulation of deep black pigment, in small raised points and berry-like tumours on the trunk and face. The pigment is deposited on the surface of the cutis, and in the latter case in its tissue also. *Melasma* occurs only in aged, decrepid, and cachectic persons, and must, of course, not be confounded with cancer melanodes.

h. Cysts.—Newly-formed cysts do not occur in the skin itself; but, instead of them, the sebaceous glands not unfrequently degenerate into cysts of large size, of which I shall speak presently. There are often also cysts in the subcutaneous cellular tissue which become, in various ways, closely connected with the corium. Such cysts very commonly contain cholesterine, which is also quite constant in the morbidly-enlarged sebaceous follicles.

i. Associated with these is the occurrence of *cholesteatoma*, as a stratum covering open ulcers of the skin. I have not only met with this upon carcinomatous ulcers, as others have observed it, but have also seen it produced exuberantly, in large masses, on an ulcer of the skin of the right knee, arising from burn.

j. Tubercle.—There appears to be no tuberculosis of the skin corresponding to that which occurs in and upon mucous and serous membranes, parenchymatous structures, &c.; at least its existence is altogether problematical. Upon ulcers, however, which arise from various exanthematic cutaneous affections of what is called scrofulous character, a product resembling softening tubercle, or puriform tubercular matter is seen, from which the ulcer obtains a character approaching that of the

ordinary tubercular ulcer upon mucous membrane, particularly the intestinal ulcer.

The skin is subject, also, to ulcerative softening of a less definitely tubercular character during the softening of tuberculous lymphatic glands, and of tubercular depositions in the subcutaneous cellular tissue, as well as when there is ulcerating tubercle in bone.

k. Cancer, and cancerous ulcer, are of frequent occurrence in the skin. Cancerous degeneration and ulceration of subcutaneous tissues very frequently involve the skin over them, and cancers of the subcutaneous cellular tissue, and of glands imbedded in it, particularly of the mammæ and lymphatic glands, usually become at an early period very closely connected with the cutis. But cancer also originates in the skin, presenting itself, according to my observations, under the forms of fibrous (scirrhus), and of medullary cancer.

a. The form which fibrous cancer assumes in the skin is that of a rounded, or rounded and tuberculated nodule; very often it is flattened, or even depressed beneath the surface of the skin, and then it lies in a sort of umbilical fossa. It is generally single, about the size of a hempseed, pea, or hazel-nut, firmly fixed, and as hard as cartilage: sometimes it is smooth and shining externally, and sometimes covered with a hard laminated crust of epidermis; and frequently it is somewhat darker than the skin around it. When examined closely, the outer strata of the nodule are occasionally found transparent. It occurs principally on the face, lips, and nose, but is occasionally found on other parts of the body: it is generally the primary cancerous growth, the first of a series of cancerous formations in different organs of the body. In some few cases it reaches a considerable size, growing out into a tuberos mass that projects beyond the skin.

β. Unlike fibrous cancer, the medullary kind is usually a secondary formation, and associated with large cancerous growths, which first appear just beneath the skin, or if they come from a greater distance, involve the subcutaneous structures first, and then the skin itself: in either case it grows in the skin in isolated or confluent nodules near the primary mass. At other times it comes on in skin after cancer has been already localised in one, and still more when it exists

in several organs; it then constitutes one part of an extensive, or it may be, of a general, production of cancer. The nodules which it forms are mostly numerous, and about the size of peas or hazelnuts; they are scattered over large tracts of the body, especially over the trunk, and near similar growths in the subcutaneous cellular tissue. It is distinguished in the skin, as well as in that tissue, as a whitish or whitish red growth, which is sometimes tolerably firm and lardaceo-medullary, and sometimes softer, looser, and resembling cerebral substance, or even diffuent like milk, and which grows to considerable size. It frequently corresponds with a character which may be possessed by the fundamental or primary growth, in also containing pigment; and in that case it constitutes cancer melanodes of the skin. The layer of skin which at first existed above the medullary nodule, becomes stretched, and sometimes is shining and transparent, sometimes rough from having lost its covering of epidermis: at a later period, as it is being perforated, it becomes moist, and furnishes the nodule with a cortical covering; and a remarkable villus-like development of its papillæ takes place, which appears, from the result of observations upon chimney-sweeper's cancer, to occur in an especial degree in that disease. Sometimes the elementary particles of the disease are deposited in a pre-existing teleangiectasis, or, as the deposition takes place, there happens an excessive development of the vessels of the skin: the result, especially in the former case, is a cancerous structure of uncommon vascularity, which then receives the name of *fungus hæmatodes*.

Chimney-sweeper's cancer, and Alibert's eburnated cancer of the skin, must be referred to as special varieties of the disease.

Chimney-sweeper's cancer appears to be of medullary nature. It almost always begins, as is well known, on the scrotum with a tolerably firm, small nodule, or a warty excrescence, which, after having existed for some time, becomes red, excoriated, moist, and covered with a cortex: the papillæ beneath it enlarge considerably, and at length the whole becomes an ulcer with irregular, hard, raised edges. Fresh nodules form around it during its progress, and, by the ulceration of these, the original sore enlarges, for the most part superficially: the nodules at the same time become developed into fungous cauliflower excrescences, and at last the metamorphosis extends deeply.

After infiltration and induration have taken place in the dartos and tunica vaginalis, and the latter has become adherent to the testicle, that gland itself ulcerates, while the adjoining lymphatic glands and the vas deferens degenerate quite up to the abdominal cavity.

The *eburnated cutaneous cancer* of Alibert is a diffused degeneration, which occurs, without doubt, only as a secondary affection, the skin being destroyed in the degeneration of cancerous growths beneath it, at an advanced stage of the cancerous dyscrasia. Over a scirrhus subcutaneous cellular tissue, the cutis is stiff and immovable, white, glistening, and somewhat transparent, and the whole mass is uncommonly firm. Although the disease is very rarely observed with so marked a character as Alibert has seen, yet now and then an opportunity occurs of examining cancerous degenerations of the skin, which in some degree approach what Alibert has described as *carcine éburnée*. It is quite uncertain, from its elementary structure, to what form of cancer it belongs, but, from the state of the disease with which it is connected, it should be the fibrous form.

From any of these cancerous growths a cancerous ulcer may be formed. Congestion and inflammation come on in and around the growth; and, while it becomes turgid, dark coloured, and vascular, and a fungous growth protrudes, it softens and splits, and, producing a cancerous sanies, breaks down. At the same time, new cancerous matter is deposited, either by infiltration or in nodules, in the tissue forming the margins and base of the principal ulcer. This metamorphosis of the cancer, as well as the softening of the secondary deposition in the ulcer, may run its course either with or without a fungous protrusion. The former is particularly characteristic of the ulcer of medullary disease; while, on the contrary, there are some remarkable cancerous ulcers, by which tissues are eroded not only without visible previous cancerous degeneration, but even without any considerable production of sanies. Ulcers of this kind do unquestionably often originate with one of the cancerous growths already mentioned; though not always, for they are sometimes developed secondarily from some injury or ulceration. They frequently produce extensive devastations, especially upon the face, and commonly attack and destroy all structures without distinction; for which reasons, as well as from

their ungovernable nature, they are regarded as cancerous : but varied and accurate investigations of all their characters are still required.

1. *Parasites*.—Several kinds of pediculus, the itch insect (*acarus scabiei*), and without doubt other acari also, occur both in and upon the skin : the subcutaneous cellular tissue is infested with the *filaria medinensis* already alluded to (p. 10).

Among vegetable productions may be mentioned the thread fungi (*fadenpilze*), which are formed in the pustules in cases of *porrigo favosa*. They are the primary anomaly, and constitute unquestionably the essence of the whole disease.

Appendix.—Anomalies and diseases of the sudoriparous and sebaceous Glands.

A. In several of the exanthematous processes the sudoriparous glands and their ducts are unquestionably subject to frequent and various diseases, both primary and secondary, but the anatomical investigation of their diseases is attended with many difficulties, and no advance has yet been made in it. Our knowledge is limited to the anomalies in the quantity and physical properties, most of them, therefore, symptomatic anomalies, of their secretion, *i. e.*, of the perspiration : but chemistry has hitherto supplied information in some striking cases only, and the investigation is beset with as many hinderances as before.

B. The sebaceous follicles and their excretory ducts are certainly the true and the original seat of many exanthematous processes ; but their most frequent morbid condition is enlargement, arising from the accumulation of thickened secretion within them. The least degree of the affection, and a very common one, is dilatation of the duct of the gland, and is known by the name of *Mitesser*,—maggots, (*Comedones*.) The accumulation of the secretion in the sudoriparous sac itself produces white rounded tumours, of the size of gravel, or millet-seed. When dilated to a greater degree, the sac degenerates, either alone or together with its excretory duct, into a cyst as large as a pea or a hazel-nut, or even larger ; when it is diseased alone it is open externally ; but in the latter case it separates from

its duct, and completely closes : it contains a whitish, laminated, firm substance, like adipocire, or a pulpy substance, viscid like fat, and consisting of strata of epidermis, and crystallized fat. In all these forms the disease occurs principally in the larger sebaceous follicles on the face, at the upper part of the trunk, on the back, and in the neighbourhood of the parts of generation.

The diseased sebaceous glands frequently give rise to inflammation of the adjoining corium—to acne,—an inflammation that sometimes goes on to suppuration of the follicle, as well as frequently of the bulb of the hair with which it is connected, and sometimes to induration (*acne indurata*), and thereby to a slow cure.

In large sebaceous cysts the epidermal mass sometimes takes the form of a horny excrescence,—a growth to which I shall advert presently. In other cases their contents become inspissated, and form calcareous concretions.

The occurrence of a condyloma in the sac of one of these glands—*condyloma subcutaneum* of Hank—is a very interesting phenomenon, which for that reason requires further investigation.

The secretion of the gland is sometimes more abundant than natural, and is poured out upon the surface of the skin (*seborrhagia*): it dries there in thin whitish, glistening laminae, or in thicker, dirty strata or scabs which feel like fat.

Anomalies and diseases of the horny tissues,—the Cuticle, Nails and Hair.

A. The *Cuticle* is subject to several anomalies, but they are not accurately known ; and their relations to diseases of the cutis require especially to be explained.

§ 1. It is very often formed in excess ; and then either its outer layers are thrown off in the form of bran, scales, larger coherent masses, &c. ; or its elementary structures, accumulating upon and beside one another, produce very various secondary formations, such as callosities, corns, and crusts, flat, convex, or concave scutes, cylindrical or angular, tessellated growths, and others which resemble stalks and thorns. Anomalies of this kind may be limited to certain circumscribed spots, or may extend over the whole body.

On the other hand, the cuticle is sometimes remarkably thin

and delicate, and, therefore, transparent, at spots where it has been recently cast off.

§ 2. An unnatural aggregation of the elementary constituents of the cuticle, and a simultaneous excess of its growth, produce the anomalies in the form of the epidermal tunic which have been already mentioned. I shall refer to this again amongst the anomalies of its structure.

§ 3. Anomalies in the colour of the skin reside for the most part in the epidermis. Its cells contain a pigment, perceptible chiefly in the deeper layers, which varies in quantity, and may be yellow, brown, or black. Such varieties in its colour constitute the distinctive peculiarities of certain individuals, and certain races, but sometimes they are acquired. In the latter case the change may be limited to particular spots, or may extend over the whole body; and it presents considerable interest from its involving not only marked alterations in the condition of the organ, and in its secretion, but also anomalies of internal organs which indicate a revolution of the entire vegetative system. Pigment accumulates and discolours the skin in a remarkable manner in congenital *nævi*.

Total absence of pigment is a congenital defect in cases of *Albinoismus*, and an acquired in cases of *Achroma* or *Vitiligo*. The former may be general or partial; the latter is at first always partial, but may at last become general.

§ 4. The epidermis deviates from its normal consistence in being sometimes more or less moist, but more commonly very dry and harsh. It is the latter condition that produces its tendency to break and peel off in the form of bran or scales, as it is observed to do in many substantive diseases of the skin, and in cases in which it is a symptomatic occurrence, and the skin is destroyed, especially by cancer. In those cases, likewise, in which epidermis has accumulated in a thick layer over a diseased spot of skin, its dry condition occasions cracks, fissures (*chaps*, *rhagades*), which not unfrequently extend through its entire thickness, and even into the *cutis*.

§ 5. The mutual relations, as to position, which subsist naturally between the elementary structures of the epidermis, are frequently disturbed, not only in consequence of their simple accumulation, but also by a simultaneous excessive development of the *papillæ* of the *cutis*, and by various other

accidental circumstances. Such anomalous relations of structure may be reduced generally to the two forms of a more developed laminated arrangement, and an apparently fibrillated structure. This class includes the anomalies in the shape of the epidermal tunic already mentioned,—

The *callosity*,—*tyloma*,—which consists of a simple accumulation of epidermis in the form of strata lying over one another ;

The *corn*,—*clavus*,—a small circumscribed painful callus that projects like a wedge into the corium ;

The *crusts*, and the convex, flat or hollowed (concave) *scutes* exhibit a laminated structure, though the granular accumulations of dried exudation and pus frequently render it indistinct : but the cylindrical and angular formations resembling pavement, stalks, and thorns, though they also consist of lamellæ of epidermis, are fibrillated, and the horny excrescences have a similar structure. The cutis upon which they grow is always diseased, though not, indeed, to the same degree in all cases ; but beneath such growths it is unusually succulent, loosened, vascular, and hypertrophied, and is developed, especially at its superficial lamina, into mushroom-like, cuneiform, thready, villous, or even cleft, papillæ. It is evidently so in genuine ichthyosis, and very probably in the milder allied forms of pityriasis, psoriasis, and lichen. The primary and the secondary changes in the tissue of the skin in lepra are alike unknown.

Horns—*cornea cutanea*—either grow upon a cutis, diseased in the way just described, or spring from its deeper part, out of a cyst, which is, in fact, a degenerate sebaceous follicle. They have been met with at various parts of the body, but their principal site is the hairy part of the head, and the forehead : they occur sometimes even on the prepuce and glans penis. Usually only one exists, but sometimes there are two or more. Their length is occasionally very considerable, even as great as several inches ; and they may be as thick as a finger : some of them are straight, others are twisted or curved ; most of them are single, a few are cloven ; their broadest part is always the base, the shaft is cylindrical or obtuse-angled, and the free extremity is generally pointed. As to colour, they are mostly dirty brownish or black. They have been several times observed to be repeatedly shed at regular intervals. And when

thus shed, or when accidentally or designedly removed, they are reproduced, provided the spot of skin which they spring from—the matrix—be not destroyed. They are somewhat more frequent in the female than in the male sex, and are common to old age rather than to other periods of life.

B. The *Nails*.

§ 1. These have in some few cases been found wanting in all, or in some of, the fingers and toes. They are very frequently absent in ill developed supernumerary fingers and toes. When such parts coalesce, the corresponding nails unite into one plate.

There are various forms in which a preternatural number of nails exists: not only are they in excess when there are supernumerary well developed fingers and toes, but even when a duplication of the last phalanx is but just indicated; and even without having any trace of being double, a finger or a toe sometimes has a double nail. After the loss of the terminal phalanx a new nail is sometimes formed over the second or first joint, or even upon the knuckle.

§ 2. The size and form of the nails are subject to several congenital and acquired anomalies. Those of the latter class are particularly frequent and interesting; for from them arise the excessive growth, combined with thickening and deformity, which the nails sometimes present in a striking degree. They reach a length of several inches, become misshapen and thick, and twisted and curved like horns and talons. The principal cause of this deformity of the nails is a want of care of them, especially when to that is added neglect or inability to employ the limbs. Of other causes we are ignorant;—a remark which applies particularly to those cases in which an exuberant growth of the nails concurs with the development of horns, &c.

On the other hand, the growth of the nails is arrested in paralysed limbs, and during the repair of fractures (Günther). They shrink too, and at the same time may be deformed or may retain their shape. When the phalangeal bones waste, the nails merely diminish in a corresponding degree; but simultaneous diminution and deformity is a state, the cause of which, and its connexion with other diseases that sometimes coexist with or precede it, are still matters of conjecture. Both in old and

in young persons some of the nails, and at last all of them, may lose their smoothness and polish, and cease to grow in length, while they increase in thickness. They then become dry, and split; first the upper shorter lamellæ are thrown off, and at last the whole nail; and the subjacent matrix gradually assumes the nature of the other general integuments, and never produces a new nail. Sometimes the disease is limited, not indeed permanently, but yet for a considerable time, to a state in which small rugged stumps of the nail remain, together with its root: in other cases the nail withers at its lateral margins first, separates from the skin beneath, becomes everted, &c.

Again, the nails present several anomalies in respect to their form, amongst which the convex shape, in cases of extreme cyanosis, is particularly marked. In lepra, in plica polonica, in syphilis, &c., the nails are, in various ways, deformed; and newly formed nails, as is well known, are usually at first misshapen.

§ 3. The consistence and texture of the nails are frequently altered, sometimes independently of disease of the epidermis, sometimes in consequence of it. In the above-mentioned diseases of the skin and hair more especially, they become loose, soft, succulent, and at the same time discoloured, or on the contrary dry, as brittle as glass, fissured, &c.

The corium which surrounds the nail is often the seat of an acute, or of a chronic inflammation, which usually ends in suppuration and loss of the nail; and in the toes, when the nail *grows in*, as it is called, is now and then attended with a very considerable growth of granulations (paronychia). In some individuals the inflammation terminates in an ulceration which has the specific character of scrofula or syphilis.

c. The *Hair* presents various anomalies:

§ 1. It may be congenitally deficient in whole or in part (Alopecia connata): the deformity which is thus produced lasts only so long as the growth of the hair is delayed; sometimes, however, it continues throughout life. Partial deficiency involves in some cases all the hair of the head, in others all that in the pubic region; or it may affect smaller circumscribed spots which remain bald. Allied to this is another condition in which the hair grows sparingly.

Deficiency of the hair is more commonly acquired (Alopecia,

Calvities), and may be transient, the lost hair being replaced by new, or it may prove a permanent defect. When the gray hair of the aged person falls out, it is permanently lost; in younger persons the loss is not preceded by any change of colour, and is often limited to certain circular spots, which become bald, and increase in extent, though there be no disease in the growth of the hair. Moreover, the hair is sometimes permanently lost in consequence of various diseases and disorganizations of parts of the skin which are naturally covered with it, or in consequence of general weakness and cachectic states of the system, such as syphilis, &c.

But again, there sometimes occurs an exuberant growth of hair: it may be very thick (numerous) at the parts where it is usually found, and grow to an uncommon length; or it may present itself in an unusual situation; or it may appear at an unusual time, either coming forward prematurely or growing anew in advanced life. Thus the hair of the head is sometimes uncommonly thick and long in women, and that of the beard in men; and in the former sex particularly, that on the pubes sometimes presents the same peculiarity. Occasionally the whole body is covered with hair (hirsuties), and sometimes particular parts of it, as the shoulders, the back, the abdomen (Osiander met with a case in which hair began to grow above the navel in a pregnant woman), or the lower limbs in both sexes: sometimes a beard grows in women: in cases of hemicephalus, the hair reaches down to the eyebrows and root of the nose; a long streak of it is found on either side of a spina bifida; hair exists also on *nævi*, &c. Sometimes children are born with an unusual quantity of hair; or again the hair appears on the pubes at an early age, the hair of old persons grows again, &c. Moreover, the hair is sometimes exuberant at certain parts, while at others it is thin; thus the beard is occasionally strongly grown in persons who have always had a scanty covering of hair upon the head, or from whom it has prematurely fallen off.

Here, too, may be mentioned the occurrence of hair upon mucous membranes, and on the inner surface of encysted tumours. In the latter case, it is almost invariably accompanied by a growth of fat, and very frequently of teeth;—a peculiarity which reminds us of the concurrent deficiency of both teeth and hair, which is sometimes observed (Danz), and of

the renewed dentition which is associated in the aged with a new growth of hair. Cysts of this kind are most common in the female sex, especially in the ovaries. Most of the hair, or all of it, lies loose, and steeped in the fat which is present with it, or rolled up in coils within the cyst: plates resembling cutis, however, are sometimes seen on the inner surface of the cyst, and upon them the pores are apparent out of which the hair has grown, or in which it is still inserted. Its development in that situation is similar to that of the natural hair.

Lastly, microscopic hair has been discovered in anomalous secretions of the skin and of various mucous membranes.

§ 2. The hair sometimes presents an excessive growth in length and thickness, especially the hair of the head, where the thickness of the shaft is sometimes considerable. Usually the hair is not only hypertrophied but closely set, and in women the growth may be so abundant as to diminish the *embonpoint* of the body.

It more frequently happens that, in consequence of atrophy of its matrix, the hair becomes thin: it ceases to grow, and becomes somewhat lighter coloured than usual, and dry, at last it falls out, and never grows again. This atrophy may be idiopathic, or it may be secondary, and occasioned by various diseases of the skin.

Moreover, there are sometimes found amongst the natural hair, some which are unusually thick, stiff, and brush-like. Albinos, on the other hand, originally have uncommonly thin soft hair, like the *Lanugo*.

§ 3. An interesting anomaly in the form of the hair is that in which it bends or breaks, and swells at the broken part into a kind of knot; or, again, that in which it splits at its free extremity, and looks like a brush. In a few cases curly hair has usurped the place of smooth; and in one case the hair of the head became curly during an attack of gout in the head. Peculiarities of this kind depend on the state of the medullary contents of the cylinder of the hair.

§ 4. Its colour is subject to many changes, some of which are observed only in extremely rare cases. The soft, thin hair of Albinos is white, and has a silky gloss. In *Achroma* the hair becomes colourless upon spots of skin that have lost their colour; but a far more frequent instance of acquired dis-

colouring is its change to gray without previous or simultaneous alteration of the skin. It is chiefly observed in aged persons, in whom it gradually extends from the hair on the head to that on the rest of the body; when it occurs in young persons, it is generally limited to the head. Small circumscribed spots of gray hair are occasionally seen in childhood and youth, and this lack of colour is generally persistent; under certain circumstances, however, hair that has turned gray becomes coloured again. But not only is it exposed to a gradual loss of its early hue as old age advances, it sometimes also changes suddenly to gray, in consequence of extremely depressing affections of the mind.

Still more uncommon are the cases in which the hair assumes a deeper shade than natural, or undergoes an actual change of colour. Paroxysms of certain diseases, of gout, of quartan ague, and even the period of ordinary pregnancy, have been stopped by it. Isouard relates, that the blond hair of a woman whom he observed, turned somewhat red as often as she had fever, &c.

§ 5. Faults in the consistence and texture of the hair sometimes present themselves as unnatural dryness, and occasion it to break and split, and, at last, to fall out; at other times, as a morbidly moist and loose condition. The latter results from the deposition of a viscid purulent matter in the pore, and is seen in cases of favus, but is far more distinct, and reaches its extreme in elf-lock, (*Plica polonica*,—*Cirrhagra*.) The hair capsule or pore in this case is tumid, injected, and filled with a pasty, opaque fluid, while the hair itself, from the root upward, is thickened, soft, and full of moisture, and its canal is dilated. It grows rapidly during life; the product just mentioned is effused at its roots upon the surface of the skin, and trickles also out of the hair itself: in this manner the hair on the head, beard, or pubes, sticks together in inextricable tangles, which resemble in shape queues, wreaths, caps, &c. This genuine *plica polonica* must be distinguished from the similar tangling which takes place in the course of acute, and especially of typhous, diseases.

PART VIII.

ANOMALIES AND DISEASES OF THE
FIBROUS SYSTEM.

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I SHALL confine my observations, in the following chapter, to the membranous, and the fasciculated fibrous structures, except in the instance of periosteum, which I shall consider as fully as can be done, without entering into the subject of diseases of bone. The morbid conditions of the remaining fibrous structures will be duly noticed, according to their importance, in connexion with those organs and apparatus, of which they form either the capsules, the connecting medium, or the fundamental structure.

§ 1. *Deficiency and excess of development.*—Fibrous membranes are completely wanting in all cases in which the organs or apparatus to which they belong do not exist: and, in like manner, a ligament or the tendon of a muscle is sometimes absent altogether. But occasionally there is no actual deficiency of either kind of fibrous structure; it is merely backward in its development, and is thin and weak, and resembles cellular tissue.

When double organs or apparatus exist, the fibrous structures are double too; and accessory ligaments, additional tendons of muscles, &c., afford other instances of plurality in this system. Moreover, there are many circumstances under which fibrous structures are developed in unnatural situations; of which we find instances in the new articular capsules of false joints; in the thick dense plates, the tough bands, and the firm, rounded or branched, callous masses of fibroid tissue into which products of inflammation and coagulable lymph are converted, when they are effused upon serous and synovial membranes, upon the internal coat of the vessels, or within parenchymatous tissues; in cicatrices generally; in the anomalous callus of bone; in the abnormal synchondroses formed after fractures; and lastly,

in the fibroid tissue which composes the walls of cysts and cystoid growths.

§ 2. *Anomalies in size and form.*—Congenital anomalies of size are presented both by fasciæ and ligaments, the former being unnaturally contracted, the latter too short: and in the instance of ligaments, it may happen that one or all of the ligaments of a joint are shorter than natural. Sometimes the shortening of ligaments or tendons is brought on after birth by some loss of substance, or want of extending power, or by a change in their texture.

At any period of fœtal, or of subsequent, life, fibrous membranes may become enlarged; and this will occur, whatever be the cause of the distension or swelling of the cavities or organs they enclose: thus the sclerotica, the fibrous capsule of a joint, &c., may be found enlarged. Sometimes the membrane becomes proportionally thinner; at other times it increases in thickness and is hypertrophied, just as is the case, under similar circumstances, with the capsule and fibrous structure of certain parenchymatous organs, of which the chronic enlargements of the spleen are an example.

Moreover, the ligaments of joints are liable to relaxation if they be immoderately stretched for some time; and in paralysed limbs they lose their tone, and elongate.

Fibrous membranes sometimes yield only in one direction; thus in hernia cerebri the dura mater expands only where there are apertures in the skull.

The anomalies of form are merely such as may be deduced from what has been said already, or such as consist of a few rare varieties in the shape of ligaments; any of which may be fissured or subdivided.

§ 3. *Anomalies of consistence and continuity.*—With the exception of a somewhat looser or closer texture of the ligaments, no alterations take place in the consistence of fibrous structures, which are not consequences of palpable disease of texture.

Amongst the solutions of continuity, those lacerations of ligaments and tendons are worthy of remark which are produced by external force and by excessive muscular action: they are more likely to happen if the tissue of these parts have been

previously softened by inflammation; when indeed they may occur upon the slightest movements.

Fibrous membranes may be ruptured by excessive distension of the cavities which they enclose, or by immoderate congestion of a parenchyma contained within them, such, for example, as the spleen; and the same accident may result from their being struck or crushed. Concussion and contusion also sometimes lead to serious consequences when they separate periosteum, or the dura mater, from bone, as they give rise to hemorrhage into the interspace, and subsequently to inflammation and the effusion of a sanious product, as well as to necrosis.

Incised wounds of fibrous structures, especially of tendons, readily heal, as recent experience proves. An exudation from the wounded tendon and other injured parts fills the space which is left between the surfaces of the wound by the retraction of the muscle, and at first unites together all the neighbouring structures that take part in the reactionary process; but afterwards it gradually becomes isolated, and new fibrous tissue is formed within it. Losses of substance are repaired in the same way, not only those which have been produced by external violence, but such also as have been caused by an ulcerative process. This fact may be observed in periosteum, or in the dura mater.

§ 4. *Deviations from natural texture.*

1. *Inflammation.*—Inflammation in fibrous structures is a frequent result of stretching and various kinds of injury, as well as of mere exposure. Not less frequently it extends to them from other organs, such as bones and parenchymatous structures, in which inflammation or suppuration is taking place; and, as fibrous structures sometimes lie immediately beneath a serous membrane, they may become involved in an inflammation of it in the way described at p. 21. Lastly, fibrous structures may themselves inflame: in which case, several parts of the system are usually attacked, either together or in succession. Inflammations of this kind are attributed to rheumatism, and to many other constitutional maladies which are described as gout, syphilis, and so forth, but they still require much elucidation.

Inflammation in fibrous tissue is sometimes an acute disease, but very frequently its course is chronic. Its characters are as follow:

It begins with the appearance of streaks of injection, and here and there of red dots which consist of small quantities of extravasated blood: the diseased structure loses its peculiar lustre, and becomes tumid, being infiltrated with a fluid of a grayish or yellowish colour, and partly jelly-like and coagulating. If the inflammation be violent, it gradually obliterates more and more, the longer it continues, all appearance of fibrous texture; the structure becomes easily lacerable, and the inflammatory product in it, most of which has coagulated, changes its colour to a dirty yellowish red, or reddish brown. In this state it resembles, as has been remarked by Gendrin, an inflamed lymphatic gland,—*i. e.* chronic inflammation of a gland.

The neighbouring tissues always share in the inflammation of a fibrous structure, but their relations to each other are altered in various ways. The homologous cellular tissue adjoining is usually inflamed in a considerable degree; and it becomes so confounded with the fibrous tissue, that the limits of either cease to be distinguishable. It is in this manner that inflamed fibrous structures—tendons and ligaments—are sometimes fixed in their bed of cellular tissue. But inflamed periosteum, on the other hand, and inflamed dura mater may be easily separated from the bone to which they belong; and some of the tunicæ albuginæ can be torn from their proper parenchyma, as if it were heterologous tissue. The loosening of the connexion is proportioned to the acuteness and violence of the inflammation in the fibrous structure.

If inflammation attack any fibrous structure, such as the dura mater or the capsule of a joint, in consequence of its being laid bare and exposed to contact with the air, it first becomes reddened, dull and villous, and then granulations appear on its exposed surface, which unite with it into an uniform, red, flesh-like, soft mass. Sometimes, especially in tendons, this does not take place until a superficial layer has perished and been cast off. The granulations change into cicatrix tissue, and by it the fibrous structure unites with, and is fixed to, the cicatrix in the other injured organs, muscles, integuments, &c.

There are numerous terminations of inflammation in fibrous structures, and their occurrence is determined by various circumstances.

Suppuration ensues chiefly when the inflammation has been

caused by exposure to the atmospheric air, and various other external irritants.

And, under similar circumstances, the inflammation leads to *ulceration*. Such is the result of inflammations which have been produced by the advance of some neighbouring ulcerative process to the fibrous structure ; as is instanced in ulcerations of periosteum or of the dura mater, when caries encroaches upon them ; or of fibrous capsules, when suppuration is taking place in the serous and synovial membranes which adjoin them. The suppuration and ulceration, in such cases, mostly advance from the surface to the deeper parts of the fibrous tissue ; while, at other times, collections of pus and sanies are found in its interior. An ulcer in fibrous structures sometimes has a sarcomatous or fungous appearance, in consequence of the flesh-like substance with which the tissue around it is infiltrated, and of the granulations which project from it.

Slight relapsing inflammations, and those which run a chronic course, end in *induration and thickening*. The soft, red, flesh-like tissue, infiltrated with inflammatory product, becomes pale and contracted, and gradually changes to a white, dense, firm, fibroid mass, which looks like cartilage. This mass generally unites closely with any neighbouring tissue, with bone for instance, which has been inflamed at the same time, and can then be separated from it only with much difficulty : but the adhesion afterwards becomes much less strong, and may, indeed, at length be entirely destroyed, if the change now described in a fibrous membrane, and the contraction and obliteration of vessels to which it leads, produce attenuation of the tissue which the membrane encloses, or if, as sometimes happens, the inflammation of an organ enveloped in a tunica albuginea be followed by a secondary atrophy of its parenchyma.

Fibrous tissue, when indurated in the manner just described, not unfrequently becomes the seat of *ossification* : that is to say, of a calcareous deposit. It is observed especially in fascicular structures, such as the ligaments, but is very rarely met with in fibrous membranes, though we find it now and then in the dura mater.

Primary inflammation of a fibrous tissue very seldom terminates in *gangrene* ; but it is a frequent occurrence when

other neighbouring structures, integuments, cellular tissue, muscles, &c., are sloughing too: it is so in the instance of bed-sloughs. The natural fibrous tissue changes into a blackish brown mass, which is soaked through with sanies of the same character, is as soft as tinder, and may be torn in any direction. It degenerates in the same manner when it has been crushed or stretched, or when those tissues which convey its blood-vessels are torn off from it, and particularly when the removal of the cellular tissue exposes it to the external air.

Inflammation frequently takes place in periosteum. In its origin and character it corresponds with what has been said of inflammation of fibrous structures in general. It may co-exist, even from its commencement, with inflammation of the bone, but it often originates as a substantive disease in the periosteum itself, and in that case always extends to the surface of the bone; or again, it may spread to the periosteum, either from the bone within, or from the soft parts without, especially from cellular tissue, ligaments, and fasciæ.

It is distinguished by the same characters as inflammation of other fibrous structures. The membrane unites closely with the cellular tissue which takes part in the process, and thus with the adjoining structures, with sheaths of muscles, aponeuroses, integuments, &c.: but from the bone it can be stripped with ease, especially if the inflammation have been at all intense, or have extended along the prolongations of the membrane into the bone, and have led to any exudation on its inner surface. Sometimes, indeed, the periosteum is found separated from the bone by a considerable quantity of purulent or sanious exudation.

Under whichever of the above-named conditions inflammation of periosteum occur, it frequently proceeds to suppuration and ulceration. There are various ways in which these results may ensue: sometimes they commence at the outer surface of the membrane, sometimes in its interior, sometimes between it and the bone; sometimes again they take place in circumscribed spots, which gradually enlarge and coalesce, while at other times extensive tracts of the membrane are found rapidly undergoing solution. (*Schmelzung*.)

Periosteum is easily replaced when it has been lost by injury; and even when it has been destroyed by ulceration, so

soon as the constitutional cause of the inflammation of the bone has ceased. The new membrane is formed out of a plastic exudation from the bone.

Chronic inflammation often leaves behind it thickening and induration of the periosteum. That membrane is then found changed into a whitish layer, which may be several lines in thickness: its texture is very close, and it is as tough as leather, or fibro-cartilage. It adheres closely to the bone, and seems intimately united with it. The condition of the bone under such circumstances varies considerably, and will be described in another chapter.

2. *Adventitious growths* are, on the whole, but rarely found in this system, though there are some fibrous structures which form an exception to the rule in the instance of particular new growths. Such is certainly the case with the dura mater in respect to sarcomatous and cancerous growths. And it must also be remembered, that in all cases in which fibrous membranes are implicated, it is extremely difficult to determine whether the new, and the degenerated growths which are imbedded in their tissue, were originally formed in them, or were developed, as undoubtedly may be proved to be far more frequently the fact, in the parenchymatous organs which those membranes inclose.

a. Cysts.

a. Single cysts of small size are not uncommon in the structures belonging to the fibrous system. Their contents may be serous, or like synovia, viscid, or gum-like, or they may consist of cholesterine. Cysts with serous contents occur chiefly in tendons, in and between aponeurotic expansions and fasciæ, and in periosteum: those which contain cholesterine are most common in periosteum, where they are known by the name of encysted cholesteatoma.

β. Compound cystoid growths are very rare: I am acquainted with but one such case. It is that of an old and ill-preserved specimen of cystoid growth, some of which adhere to the periosteum, while others are contained in the muscles of the same lower extremity.

b. Fibroid tissue is formed in fibrous structures, especially in ligaments and periosteum, when they have been swollen and thickened by chronic inflammation: it is also found in

what are called fibrous tumours. These tumours are met with chiefly in periosteum, and in the dura mater: and they present the various characters of the soft, succulent, and delicately-fibrillated tumour, filled with numerous elementary cells; of the spongy tumour composed of interwoven celled fibres, and of that which is dense and compact, and consists of well-formed fibrous bands. Their size is very uncertain, varying from that of a pea to that of a walnut or a fist; in a few cases, especially of genuine compact fibroid tumours, they are even as large as the head of a child.

c. Fibrous structures *ossify* in various ways. Not only are they liable to calcareous deposition, but when hypertrophied and indurated after inflammation, they sometimes have osteoid tissue developed in them. Sometimes it is formed in the substance of the fibrous structure, and resembles needles, cords, or plates, or is altogether shapeless; at other times it is a more or less complete incrustation upon its surface. Under such circumstances, a certain amount of vascularity is observed in the fibrous structure; it becomes of a brownish-red colour, and remains, after the bony matter has been deposited, blackened with pigment, and uncommonly dry. Bony growths of this kind are formed for the most part in the fibrous capsule of the spleen, in the dura mater, and in the fasciculated articular ligaments. Of course similar productions are found in the fibroid tumours of fibrous organs.

But not only is osteoid tissue produced in fibrous organs; in some cases we find true bone in them. The exudations from periosteum and from the dura mater on the surface next the bone, become, when they ossify, normal bony tissue. They form broad, thin layers, or thicker, circumscribed plates and shapeless masses, and enter, for the most part at once, into organic connection with the bone beneath them. They are all included under the name of osteophyte and exostosis, whether occurring as a growth of bone in various tendons, as ossified callus in articular capsules after the occurrence of fractures within joints, or as ossification of fasciculated ligaments in cases of ankylosis, &c.

d. *Tubercle*.—Tubercle is on the whole but rarely met with in fibrous organs; and when it does occur, it is almost only on the periosteum of spongy bones, and on the dura mater. In the

usual mode of its origin, inflammation gives rise to a tubercular product, which is deposited in the tissue of the membrane, or on that surface of it which adjoins the bone: it degenerates into a mass of caseo-purulent matter, and being inclosed in a capsule of fibrous structure, which is infiltrated with lardaceous-gelatinous substance, it forms loose, pulpy swellings. By the progressive formation and degeneration of tubercles in the adjoining fibrous tissue it advances in the membrane, and to the bone; and frequently produces, especially in the spine, destructive ulceration of the periosteum and ligamentous apparatus along an extensive sinuous track, as well as caries of the bones.

Occasionally these sinuses close, and their contents become chalky. They are very commonly associated with tubercle in the cellular tissue, and in the lymphatic glands, and very often with tubercle in the lungs. This subject must be resumed in the chapter on the diseases of Bone.

e. Sarcoma and cancer.—All fibrous structures may be destroyed by adjoining cancerous disease. In periosteum and the dura mater it occurs also as a primary disease, and from the former structure especially, it soon advances to the bone. Fibrous and medullary cancer are the kinds mostly observed in periosteum, but those which occur in the dura mater are very various, and differ remarkably in their elementary structure. Further remarks on this subject will be made in the chapters on the diseases of the Bones, the Joints, and the Dura Mater.

Note.—Some diseases have been described under the names of gummata, periostoses, and Cooper's cartilaginous and fungous exostoses; they will be found to be either a circumscribed inflammatory swelling and induration of the periosteum, or one of the adventitious growths which have been already described as occurring in it, or they will correspond with some of those to be hereafter brought forward amongst the diseases of Bone.

PART IX.
ANOMALIES AND DISEASES OF THE
OSSEOUS SYSTEM.

PART IX.

ANOMALIES AND DISEASES OF THE OSSEOUS SYSTEM.

CHAPTER I.

ANOMALIES AND DISEASES OF BONE IN GENERAL.

§ 1. *Deficiency and excess of development.*—The entire bony fabric of the body has been found wanting in some few cases of monstrosity, and even in some individuals whose development in other respects was quite natural. A partial deficiency of the skeleton is less unfrequently observed, as it occurs in various parts of the body where development generally has been arrested; in the thorax, for instance, and the pelvis, and especially in the limbs. There is very commonly no bone in supernumerary peripheral parts, whether fingers, toes, or limbs.

Moreover, the skeleton very often falls short of its complete development, in being altogether cartilaginous, or at least very imperfectly ossified, at the time of birth. This condition, known as congenital rickets, sometimes continues to a later period of life, and betrays itself by insufficient firmness and power of resistance in the bones, by persistence of those characters which belong to the skeleton in childhood, by the apophyses remaining separate, &c. It is very commonly combined with hypertrophy of the white substance of the brain. In some cases the complete formation of the bones is retarded by long-continued and exhausting diseases, and in some parts of the skeleton it is very frequently arrested, to a great extent, by pressure from within; as, for instance, in the skull.

An excess of development is exhibited, on the one hand, when the whole skeleton, or parts of it, are completely formed at an unnaturally early period; as when the fontanelles close, the sutures disappear, the epiphyses unite with the diaphyses, the teeth are cut, &c., prematurely; and, on the other hand, it is seen, also, when the bones are unnaturally dense and hard,

when they grow out and enlarge in some unusual direction, or when various new bony formations are found upon them.

The bones may vary in number either way; they may be more numerous or fewer than natural. When certain parts are wanting, or exceed their natural number, the corresponding bones are wanting or supernumerary too: but this may be the case also when a part appears to be naturally formed, as we find exemplified in the toes and sesamoid bones, in the vertebræ, and the ribs. The most frequent instance in which the number of the bones is unusually great, (although it is only an apparent excess,) is when the pieces of which a bone is composed continue separate, or when, in the skull more particularly, unusual sutures, or sutural (Wormian) bones exist. The want of a bone is sometimes made up for by a supplementary increase in the bulk of a neighbouring bone.

§ 2. *Anomalies in size.—Hypertrophy and Atrophy in particular.*—The anomalies of this class present many varieties, both when the volume of the bone is greater than natural and when it is less.

An *increase* in the size of the bones occurs in various forms.

1. They may grow to a greater length than natural. In giants this excess prevails in the whole skeleton; but sometimes it is observed only in particular fingers, toes, or limbs; in the latter case it may be congenital, or may come on after birth, during the period of childhood or youth.

2. The increase may take place in the breadth and thickness of a bone, at the same time that its texture becomes more dense, and its weight greater. This is hypertrophy, hyperostosis; it may extend over the whole of a bone, or be confined to particular parts of it.

3. The enlargement of a bone may be a consequence of expansion of its texture—of dilatation of its Haversian canals, and, in long bones, of the medullary cavities. It is by this change that the enlargement of cavities which are made up of bones, especially of the skull, is effected: it arises from pressure on the bones from within.

4. Enlargement is sometimes occasioned by the development of various kinds of adventitious growths and tumours in bone.

The volume of bones is *less* than natural,—

1. When the whole skeleton, or a part of it, as the head, or one or more of the limbs, has failed in attaining its full growth, whether its small size be observable at birth, or be first exhibited at a later period in a dwarfish growth of the body. Congenital dwarfishness is distinguished generally by an arrested development of the extremities in length, which is at once seen on comparing them with the skull and vertebral column; by the striking appearance of thickness which the articular ends of the bones consequently obtain; and by their deformity generally. Although congenital dwarfishness manifests on the whole a seeming alliance with those changes which are produced by rickets in the growth and form of bones, yet it cannot be certainly said to be due to the existence of that disease in the fœtus: its pathology is still unsettled.

2. Or else the small size of bones proceeds from atrophy.

A. *Hypertrophy—Hyperostosis*.—Bone increases in substance in two ways, which are not essentially different from one another.

1. In the one case, while the density of the bone remains unchanged, new osseous substance is deposited on its surface, beneath the periosteum, and augments it in breadth and thickness. The size of the medullary canal remains the same, but the compact substance around it is thicker than before. (External hyperostosis.)

2. In the other case, the increase of substance is internal, proceeding from the Haversian canals, and in the end from the whole medullary system. The bone becomes more dense, not only in its compact layers, but also in its cancellous part; the walls of its cells, and the bony threads of which its network is composed, increase in thickness; and, by a kind of concentric hypertrophy, as it were, the medullary cavity diminishes in size, and the diploe disappears. We may call this state an internal hyperostosis; it constitutes also the induration (sclerosis) of bony tissue.

The two forms very commonly occur together, and thus in a two-fold manner augment both the bulk and the weight of the bone.

Each is the result of the gradual formation of too great a quantity of the cartilage of bone, in which the normal salts of lime become deposited: both affect compact bones, as the cranial bones, the central piece of the long bones, chiefly but not

exclusively; for a somewhat striking density and resistance of the spongy bones also, especially of the vertebræ, is frequently observed in persons about the period of youth and manhood. They become very important diseases, when they proceed to any great extent, or involve important parts of the skeleton, such, for instance, as the skull; or when they affect large portions, or the whole, of the skeleton. No previous disease has occurred in the texture of the bone, which can be regarded as a preliminary or a causative process: its surface is level and smooth, the periosteum is natural, and, even when the induration attains the density and hardness of ivory, the bony texture is, in other respects, natural. Nevertheless, it must be remarked, that in advanced cases of hyperostosis, the new ossifying substance is very commonly deposited unevenly, more at one part than at another, and that thus, at length, the bone acquires a misshapen and coarse appearance.

It is sometimes observed, that while one bone is in a state of hyperostosis, another is wasted: this is frequently the case in the skull, where, when the cranial vault is hypertrophied, the bones of the face and of the base of the skull are atrophied.

In other cases, the increase of substance, both the internal and the external, is occasioned by an inflammatory process. Sometimes the inflammation attacks the outermost layer of a bone and the periosteum; sometimes it affects the deeper-seated capillaries, and sometimes the medullary membrane. In the first case it produces an exudation on the free surface of the bone, which becomes converted into an osseous layer, compact like the surface on which it is effused, though sometimes separated from it by diploetic spongy substance. In the last two cases, the increase of substance is within the bone, and leads to induration, either of the compact tissue, or of the inner spongy portion. These conditions have been called by Lobstein, *sclerosis supra-corticalis*, *corticalis*, and *centralis* respectively; they are, however, very rarely independent and separate, though one form frequently predominates in one or other portion of the bone. Generally, before they take place, the texture of the bone becomes expanded in consequence of swelling and infiltration of the tissue which connects the capillaries of the medullary canals and cells—that is, those spaces are dilated: and as the process usually occupies only

single bones, and is not uniform in its degree at all points, the hyperostoses which result are also confined to single bones, the diseased bone is thicker than natural, and very often is, from the first, of unequal thickness and coarse: its external surface is uneven and rough, nodulated and full of fissures, like the bark of a tree, or covered with thin, leaf-like inequalities; it is rendered porous by the permanently dilated orifices for its vessels, &c.; and the periosteum, and its prolongations inward, are thickened and hypertrophied.

The hyperostoses and indurations belonging to this class, are, for the most part, results of chronic inflammations, especially those of a syphilitic or gouty character. I shall have some general remarks to make upon them in a more suitable place, when considering the question, whether the hyperostoses, which these diseases set up, bear any marks by which they can be distinguished from one another.

Lastly, there are yet other cases in which hyperostosis, especially the internal (the induration), is occasioned by previous softening and expansion of the texture of the bone. The secondary indurations will be considered with the diseases of the texture of bone, that they may be arranged amongst, and shown to arise from, them; for those indurations have their origin, not merely in the ordinary ossification, within the bone, of a too abundant cartilage, but most probably, either in the ossification of a diseased cartilage, whilst the earths and salts, which are deposited, are abnormal as well as normal, or in overloading the cartilaginous basement with salts, which yet are normal. In either case the anomaly is one of texture.

Hyperostosis presents itself further in different forms as a local disease, confined to small spots on one or more bones. Its two principal forms, though intermixed in some respects by their transitions into one another, are yet, in many essential points, distinct: they are the common exostosis or bony excrescence, and the new growth, which has been named by Lobstein, the osteophyte.

a. Exostosis.—By the term exostosis should be understood a purely bony mass, set upon a bone, forming with it an organic whole, and, where it is possible, originating, or proceeding, from the bone. When its development is complete, and often at the beginning of its growth, its texture is always homologous

with that of its base and point of origin, whether that be compact or spongy. Hence all new growths upon or within a bone, which hold any other relation to it, are excluded, although they be composed more or less of normal bony texture, and even although composed of such texture altogether. Bony growths, however, which proceed from the periosteum, but sooner or later become united with the bone, are admitted.

The most important varieties in an exostosis relate to its texture, to the point from which it originated, (though in many cases this cannot be determined with certainty,) and to the mode of its development. To these varieties the sundry and wide differences in its size, form, mode of attachment, &c., are mainly referable.

Exostoses are composed sometimes of compact, sometimes of spongy bony substance: and although some are made up of both these substances, yet the division into those which are compact and those which are spongy is so far valuable, that it expresses their original condition and their development.

a. The most frequent of the exostoses is the compact. It occurs on compact bones, and parts of bones, particularly on the outer table of the cranial bones.

It appears as if it had been planted on the surface of the bone from without: in general it is a plane convex nodule, the margin of which is abrupt, and often separated from the bone beneath by a furrow. This furrow is generally narrow, sometimes being but just perceptible, and about the thickness of a hair; but frequently it is deep, and forms a fissure between the tumour and its basement. It gives the exostosis the appearance of having been glued on, or of sitting, mushroom-like, on a very short stalk.

Not only is this exostosis in all cases compact, but it often exceeds in density the bone from which it springs: it is then known as the ivory exostosis. It is especially liable to be formed on bones which are themselves indurated.

It is compact from the very first; and grows in such a way, that the layers which are added to it always at once become as dense as ivory. Neither the most superficial and most recent strata, nor the smallest of those exostoses, which form near larger ones, even though no larger than hemp-seed or a lentil, is ever seen to contain any spongy structure. New layers and

old, large exostoses and small, are equally dense and hard. When they are minutely examined, the number of peripheral lamellæ is found to be very considerable; and the corpuscles lying amongst them are long. The Haversian canals are small and far apart, and many of them are surrounded by a distinct and completely defined (völlig abgeschlossenen) lamellar system. With regard to the corpuscles, we find large tracts without any of them, while at other spots they are clustered together in dense groups.

The number of these exostoses occurring in one person, and even on the same bone, is sometimes very considerable; especially if the very small ones, which are easily overlooked, be also enumerated. I have met with them almost exclusively on the skull, where, like induration, they do, in fact, most frequently occur; but they are likewise observed on the long bones, and on the bones of the pelvis.

They vary in size from that of a flattened hemp-seed or lentil, which is scarcely perceptible, to that of a walnut, or a hen's egg, and even to greater dimensions. Their most common size ranges between that of a pea and that of a hazel-nut.

While their usual form is that of a plane convex nodule, their surface, whether even or uneven, is always smooth and polished. If they grow beyond the ordinary size, they become round, or oval, or, as they generally rather increase in length, they form a more or less cylindrical, horn-like projection. There is another form which occurs with them on the inner table of the skull near the frontal crest: it has a peculiar humifuse¹ character, or the appearance of a convoluted wreath.

The colour of these exostoses is white or yellowish white, —whiter than that of the bone to which they are attached.

As we cannot associate exostoses, in respect to their cause, with the various inequalities and nodules that occur on bones from constitutional disease, especially from syphilis, the occasion of their origin must be said to be unknown. As I have already remarked, they are very generally found on the bones of the skull, of which one or more are at the same time the seat of induration, and not unfrequently bony formations are found also on the dura mater.

¹ ["Humifuse"—growing parallel to the surface, but attached only at its point of origin, like the stems of plants which creep along the ground without taking root. (Palmer's Pent. Dict.) Ed.]

β. The spongy exostosis proceeds from a circumscribed rarefaction, or expansion, of the bony tissue (osteoporosis); it forms a tumour of cellular texture abounding with marrow, which is surrounded by a compact layer or rind. It is sometimes developed from compact bony tissue, sometimes from spongy substance, and either from the peripheral laminae of the bone, or from its interior. It presents, accordingly, many striking varieties of external form and of internal structure. Its rind or external layer unites with that of the bone; its surface is uneven.

Sometimes it forms a slight, rounded elevation above the surface of the bone, sometimes a more sharply circumscribed, hemispherical tumour; or it has a still narrower base, and is globular.

We not unfrequently find, near or upon the articular ends of long bones, and especially on the tibia and femur towards the knee-joint, a rounded, gnarled, and uneven excrescence, sometimes lobulated, or branched, and set upon a well-formed stalk; sometimes it has the form of rounded or angular, thorn-like processes. Such excrescences may be occasionally found near the articulations on most, if not all, the long bones of a skeleton.

Lastly, there is another form of exostosis allied to the spongy form, which has not only a spongy texture within its compact rind, but also a well-formed medullary cavity communicating with the medullary tube and cells of the bone; and thus presenting, as it were, a dilatation of the medullary cavity beyond the surface of the bone. Whether such really be the mode of origin of this form of exostosis, and a central cavity of this kind, communicating with the medullary tube of the bone, really exist from the commencement of the disease (in which case this exostosis would clearly rank with the spongy form), or whether the central cavity be formed in it subsequently, as it is in callus, is as yet unknown.

In the skull, the expansion of the diploetic structure sometimes distends both the compact tables, and thus there is an internal exostosis corresponding with the external.

The spongy exostosis continues for an indefinite period in its original spongy state: not unfrequently perhaps it may remain so permanently; but more commonly new substance is deposited in its interior, and more or less induration ensues. The compact exterior wall acquires considerable thickness, and encloses a mass of cancellous substance, or a well-formed central cavity:

sometimes spots in its interior are found compact too, or it may even become uniformly solid throughout.

In some parts, and even in the whole of the exostosis, a renewal of rarefaction, or osteoporosis, very often appears to succeed this process of condensation. It may be in this manner that the growth of the spongy exostosis from within outwards is chiefly effected.

They very often grow to a considerable size.

Exostoses are formed, as a general rule, in the outer layers of a bone, and they grow and project outwards: but, in a few cases, they have been seen to advance in the opposite direction, and protrude within the medullary canal. They are then named enostoses,—a name which we are accustomed to give to exostoses which project into a cavity, such as the skull, the orbit, or the pelvis. Sometimes both are met with together. An exostosis which encircles a cylindrical bone more or less completely, is called periostosis; and so on.

The cause of exostosis is not yet ascertained. It occurs, but not constantly, under certain local circumstances, as after a blow or a fracture; in the latter instance, it is merely exuberant callus; and no definite and clearer cause for it can be assigned. In most cases the periosteum covering the exostosis is in its natural condition; sometimes it is thicker than natural, and hypertrophied, and adheres with unusual firmness.

Exostoses are found in every period of life; those of the spongy kind occur even in children and new-born infants.

Usually, when they have reached a certain bulk, they continue for the remainder of life unchanged. Sometimes, and even in cases of the ivory exostosis, they have been observed to diminish in size, either by absorption, or, as it were, by contracting, while, at the same time, their structure increases in density. Spongy exostoses sometimes become carious and are destroyed; while, in a few cases, the ivory exostosis appears to have been attacked with necrosis, and thrown off.

The callus deposited around fractures frequently resembles the exostosis; and one form of the osteophyte resembles it still more: it is that which is occasioned by a circumscribed chronic inflammation of the outer layer of a bone, and which finally becomes condensed (sclerosed), and adheres to its surface. Lastly, there is one form of bony growth yet to mention, which is

produced at first by the dura mater or the periosteum on the side next the skull, and afterwards unites with the bone. It is generally flat, and the surface by which it adheres to the periosteum is rough: it is most frequently found on the inner table of the vault of the skull, where, as a product of the dura mater, it fits into the depressions of the vitreous table, and becomes firmly soldered on.

b. Osteophyte.—Although no well-marked line of distinction can be drawn between the exostosis and the osteophyte, yet the latter presents such striking peculiarities, that, in the majority of cases, it may at once be recognised, and is but rarely liable to be confounded with the former.

Unlike exostosis, the osteophyte mostly occupies extensive tracts on a bone, investing or springing from it in a great variety of forms. Moreover, it is generally the product of an inflammatory process in the superficial part of the bone and in the periosteum, and hence is very commonly found adjoining and surrounding not only portions which are inflamed, carious, or necrosed, but also spots of bone affected with various other diseases, which in some stage of their existence have occasioned a reaction in the tissue of the bone. This explains why the osteophyte is found chiefly upon and near vascular portions of bones; as on and near their articular ends, on their rough lines, &c.; and why in the skull it mostly occurs near the sutural cartilages. Regarded in this view, the osteophyte acquires a further and special interest; for as certain processes in bone, arising from a constitutional affection, appear to produce a definite and peculiar osteophyte, the nature of a disease can be determined by the characters which the osteophyte presents. I shall have an opportunity hereafter of introducing what I have observed on this subject; it may, perhaps, be deemed a contribution to our knowledge of diseases of bone, in its present incomplete state.

In the first place, Lobstein has conceived that a distinction should be drawn between exostosis and what he denominates osteophyte. I shall not, however, follow his subdivision, but shall attempt to give a more practical representation of the disease.

a. The *velvety villous* osteophyte sometimes appears as a single and very thin layer, resembling a coating of hoar-frost;

sometimes it measures one or two lines or more in thickness. It seems to be composed of delicate fibrils and lamellæ, which are fixed at acute angles on the surface of the bone, and give it the appearance of velvet, or of felt with a very fine nap. As it increases in density it gradually acquires a smooth exterior, which is pierced with very numerous fine pores; while its deeper structure is more distinctly laminated. Although, at first, in contact with the bone, it is usually almost entirely unattached to it, and can easily be raised in large pieces from its surface. The osseous surface under it is sometimes as smooth as in the natural state; but sometimes we find, upon close examination, that it has lost its smoothness, and is distinctly rough, the pores for its vessels being somewhat enlarged, and its outermost layer here and there expanded into filaments. At a later period, the osteophyte is found attached to the bone by some intervening minute round pillars and plates: after having gradually become compact, it unites with the bone. A layer of cellular (diploetic) substance forms for some time a line of demarcation between it and the bone, but when this disappears, the osteophyte and the compact surface of the bone compose one uniform whole. It corresponds to the "*osteophyte diffuse et fibrillo-reticulaire*" of Lobstein. Sometimes, as an exception, it is produced in more considerable quantity, and forms an intimate connection with the bone, uniting with the filamento-cellular structure into which the outer layer of the bone expands.

Should the periosteum have taken part in the process by which the osteophyte is produced, that portion of the exudation which attaches to it, becomes organized into a vascular cellular tissue, while that which belongs to the bone, and which ossifies, forms a compact osseous layer: the surface of the latter presents a great number of pores, and of exceedingly tortuous and convoluted half canals, which have been occupied by the newly-formed cellular tissue, and its vascular twigs. We notice this chiefly when such an osteophyte is situated on the inner table of the skull.

The colour of this osteophyte in the recent state depends on the intensity of the process which produced it, on the period of its existence, and on the progress of its ossification: and it varies accordingly from bluish or rosy-red to yellowish and

dirty white, or it may be a dazzling white, and glisten like silk or asbestos. At its commencement it is a soft, gelatinous exudation; afterwards it becomes tough and elastic, like cartilage; and finally it ossifies.

This kind of osteophyte is seen chiefly on compact bones. It accompanies almost all inflammatory processes, abscesses, and necrosis in bone, especially in young persons with abundant fluids (succulent): it frequently extends from the diseased spot over considerable portions of the surface of the bone, while it accumulates in greatest quantity in the immediate neighbourhood of the disease, and occasionally on the rough lines, &c. It is very frequent in the skull, especially on its inner table; and on that part particularly there is a bony growth, which has some connection with pregnancy, and which we call the *puerperal osteophyte*. It possesses great interest, and will receive a fuller consideration when we come to treat of the diseases of the cranial bones.

β. Allied to this osteophyte is another which I will call the *splintered and laminated osteophyte*. It presents itself in the form of rather large excrescences and lamellæ, which measure several lines in length, are conical in shape, and mostly terminate in a sharp point: they are composed of a compact wall, pierced with fine pores, which incloses a coarsely cellular, osseous tissue, or even a single (medullary) cavity. It is chiefly, and indeed commonly, abundant in the neighbourhood of the cancellous parts of a bone affected with caries, especially caries of the articular ends of bones in young subjects, which is generally considered to be of scrofulous nature.

γ. *Warty and stalactitic osteophyte*.—This is a bony growth either of excrescences resembling warts and attached sometimes by a broad base, sometimes by a pedicle, or of larger, irregular, rugged masses resembling stalactites. It seems to be found only in the neighbourhood of the joints; it accumulates particularly around enlarged articular concavities, forms a tuberculated addition to the margin of articular heads, which have been flattened out like a mushroom, and thence extends in abundance also to adjoining rough parts of the bone. They generally consist of a chalky, white, very brittle substance; they occur most commonly on the hip bones, and appear to be connected with gouty metamorphosis of that joint.

δ. The osteophyte in the form of thorny or styloid, single or branched plates, or of rounded, gnarled, and pediculated processes, occurs chiefly on spongy bones, on the vertebræ, and the bones of the pelvis, selecting in both these instances the neighbourhood of the synchondroses. It occurs also on the articular ends of bones, and very frequently follows, as it grows, the direction of the fibres of the periosteum, ligaments, tendinous insertions of the muscles, intermuscular septa, interosseous membranes, &c. When growths of this kind spring from two adjoining bones, they frequently meet somewhat in a symmetrical manner, and unite together: in this manner they inclose the synchondrosal cartilage in a more or less complete bony capsule, and give rise to a peculiar kind of ankylosis, which is often observed on the bodies of the vertebræ. Not unfrequently they supply the place of callus which has been arrested in its development, and imperfectly unite the ends of broken bones. Similar formations are sometimes seen around the cloacal openings in the capsule of a sequestrum. They arise from a chronic inflammation of the bones, in which the periosteum and ligamentous apparatus become involved: they are often found on the vertebræ of old persons, and while the bone to which they are attached, as well as some others, or even the whole skeleton, is atrophied, the osteophyte itself is of dense structure, and hard.

ε. There is another osteophyte, which looks as if a quantity of bony matter had been poured over a bone, and had coagulated as it flowed. It forms masses which sometimes give the impression, that the bony substance had been *dropped* upon a bone, and had then solidified; in which case the surface of the mass, whether even or uneven, is smooth: at other times it appears as if the bony matter had been *poured* in a stream over larger surfaces of a bone, and had then coagulated. This osteophyte is compact. I have seen it on the inner table of the skull, when the cranial bones were indurated; and have met with it still more frequently covering a considerable extent of the anterior surface of the vertebral column in old persons, and producing ankylosis of the vertebræ.

In accordance with the foregoing descriptions, I exclude from amongst the osteophytes all those bony growths which form a more or less complete external capsule, or an internal radiated

thorn-like skeleton, for the various adventitious structures that occur in bone, whether enchondroma, osteosarcoma, or cancer; as well as those which are found at the base of similar adventitious structures in the softer organs.

Osteophytes have in some few cases been observed covering large portions, and even almost the whole of a skeleton. Sometimes they are accompanied by hypertrophy, sometimes by atrophy of the bones. We are quite ignorant of any general diseased condition of the system to which this can be attributed.

The periosteum may not share in the diseased process going on in the exterior of the bone, and then it remains nearly unaltered; but if it do take part, it becomes vascular, reddened, infiltrated, and thickened (hypertrophied), and furnishes sheath-like prolongations, which invest the more bulky of the bony excrescences.

The changes which the osteophyte undergoes in the course of time have been already partly noticed. The fibrils and lamellæ which compose the velvety osteophyte approach each other and increase in size, and, at the same time, assume a position parallel to the lamellæ of the bone beneath them; the whole osteophyte becomes more dense, and unites either immediately or by an intervening layer of diploe, with the bone. Hence the bone becomes a layer of compact tissue thicker—Lobstein's "supracorticale osteosclerose." In other cases, as the velvety, or the splintered and laminated, osteophyte becomes condensed, its fibrils and lamellæ retain their relative position to the bone, and the osteophyte becomes a compact osseous mass, which, though attached to the bone, can be distinguished from it by the different direction of its lamellæ and the course of its medullary canals. Sometimes the osteophyte appears to be diminished by absorption, but it can hardly disappear altogether.

B. *Atrophy*.—Atrophy of bones occurs under many forms and various circumstances.

(1.) After a long-continued and exhausting disease of bone, such as caries, after exhaustive healing processes, such as fractures, (and injuries generally,) or in consequence of palsies, neuralgia, or ankylosis, single bones, or large portions of the skeleton may diminish in volume. They retain their normal texture, but diminish in length, and still more in thickness;

an entire bone becomes small, and its medullary canal contracted,—it is in a state of *concentric atrophy*. And in connection with this fact, and in opposition to that increase in the volume of bones to which I have before adverted as a consequence of distension of the cavity which they form, I may mention that bony cavities diminish, or sink in, when atrophy or loss of substance happens to the organs contained within them.

(2.) Bones are subject in old age to a form of atrophy (senile atrophy), in which their consistence and strength are so far changed that they not only become soft and flexible, and are easily indented, but rather acquire something of the brittleness of glass. (*Fragilitas Vitrea*. Osteopsathyrosis of Lobstein.)

Atrophy appears always to commence with the medullary tubes and diploetic structure: the cells of the latter enlarge, and its walls, as well as the bony threads composing the cancellous tissue, become attenuated, and at length disappear entirely. The compact substance yielding next, is all changed into spongy, diploetic tissue, except its outermost layer, but though that remains compact, it becomes extremely thin, and is sometimes scarcely as thick as a sheet of paper. As the atrophy of this once solid, but now spongy, substance becomes more complete, the outermost layer alone remains, encompassing either a cavity, which contains some mere traces of spongy tissue at its periphery,—a cavity relatively dilated (*excentric atrophy*), or a soft substance, with very coarse cells; or lastly, when the diploe is entirely removed, the extremely thin remaining parts of the walls of the bone approach each other, and coalescing form a single thin plate. Examples of the first change are presented by the larger medullary tubes; the second is seen in the smaller cylindrical bones, in the pelvic bones, ribs, and vertebræ; while the bones of the face, and small spots, which are limited to the top of the parietal bones of aged persons, exhibit the last. Finally, should the atrophy proceed to an extreme degree, and involve the last remaining thin layer of the wall of the bone, its surface becomes rough and porous; and, however easily the periosteum may be stripped off elsewhere, it cannot be removed from this spot without bringing away a layer of bone with it.

The medullary tubes and dilated cellular interspaces are

filled with marrow, which is usually of a dark, and often of a brownish-red, or a chocolate colour.

The description given above sufficiently explains how it is that the bones become unusually flexible, and easily crack when they are bent; that upon making moderate pressure on spongy bones the finger breaks into them; that the cylindrical shafts, being reduced to a thin compact wall, break upon the slightest occasions; and that, in advanced age, the well known curvatures of the vertebral column occur, and other portions of the bony fabric of the body become, under certain circumstances, crooked and deformed.

As the bones lose substance in their interior, they shrink in their external bulk: and hence the skeleton in old age becomes smaller in all its dimensions, and the weight of the body less.

Senile atrophy runs a chronic course, and is unattended with pain: in its earlier stages the muscles also waste and the lungs become atrophied; and afterwards the diminution of the bones is attended with decay (involution) of all the other organs: the muscles are sometimes the seat of fatty degeneration. There are some diseases of bone, which, in their anatomical characters, present considerable resemblance to this form of atrophy; but, although hitherto thought much of, those characters are in themselves unsatisfactory. They are diseases which affect persons unlike those in whom senile atrophy is met with, and in their symptoms and course they materially differ from it. As they are processes connected with constitutional disease (dyscrasia), and we partly recognise in them, and partly have reason to assume, the existence of important qualitative deviations from a healthy state of the organization, I shall speak further of them under the head of morbid expansion and softening of bones.

(3.) A third form of atrophy is that in which bone is worn away or absorbed (*Usura, detritus ossis*). Being occasioned either by uniform and permanent, or by repeatedly renewed (pulsatile), pressure upon the bone, the breach of substance is always circumscribed. Various tumours, which form in the soft parts adjoining a bone, especially in periosteum, produce this effect with different degrees of force: the walls of the skull, for instance, are pressed upon by the Pacchionian bodies, by sundry

adventitious growths, commonly known by the collective name of fungus of the dura mater, by tumours in the brain, even by the brain itself, when enlarged or displaced, by large apoplectic cysts, by an enlarged and diseased pituitary gland, &c.; the bones of the face suffer from the pressure of fibrous tumours (fibrous polypi), of sarcoma, and cancerous growths developed in the nostrils, frontal sinuses, antra Highmoriana, or orbits; but the most frequent cause of pressure is aneurismal tumours, and the common seat of it is the bones of the trunk and limbs.

The degree and the extent to which the bone is worn away varies in different cases, the former depending on the amount and duration of the pressure, the latter on the size of the tumour: one or more bones may be entirely destroyed, or a bony wall may be perforated, as is often strikingly illustrated in the progress of aneurismal tumours. As large tumours press unequally, the destruction of bone, when very extensive, is generally not uniform: for the same reason its boundaries are not sharply defined.

Small tumours, which exert uniform and very moderate pressure, and even larger tumours, when they grow slowly, occasion, first, flattening, and then an excavation of the bone on which they press, but do not disturb the smoothness and polish of its surface. The bone immediately around bulges out, and appears not as if it had sustained an actual loss of substance, but rather as if its substance had been merely thrust aside. When pressure is made on one of two compact tables, especially in the skull, it is not so much that table which seems to be absorbed, as the layer of diploe beneath it; the two tables are in this manner gradually brought nearer together, and at length come into contact and unite. I find this borne out by many well-marked cases in the University Museum at Vienna; as well as by most of the pits on the inner surface of the skull, in which Pacchionian bodies have been imbedded.

If the compact wall of a bone be subjected to considerable pressure, it disappears layer by layer, becomes rough on the surface, and when at length entirely absorbed, leaves the cancellous tissue beneath it exposed. A very manifest effort of nature is then often perceived to resist the injury, and to maintain the integrity of the inner texture of the bone. The cancellous substance, increasing in density by the addition of

bony matter to its lamellæ and threads, strives to become compact, and exposes to the pressure a stratum as capable of resistance as possible.

This wearing down (detritus) of bone may easily be confounded with the loss of substance which results from caries; and the difficulty of distinguishing between them is sometimes augmented by their both occurring together. For, to take a frequent instance, that of softening malignant tumours, not only is the bone worn away by the pressure which such tumours exert, but inflammation and suppuration are set up in its exposed spongy texture, or corrosion on its surface, by the ichor which they discharge.

Absorption (detritus) is distinguished from caries by the absence of any change of texture, either at the spot itself, or around it; and by there being neither purulent nor sanious product, nor any osteophyte. The tendency to condensation which is exhibited in the substance exposed to pressure furnishes a further distinctive mark of the detritus.

Finally, bone may be absorbed in consequence of pressure from within: the various tumours developed in the spongy substance, and medullary cavity, the fibroid tumours, enchondroma, osteoid growths, sarcoma, cancer, and the dilatations of the capillary system of the vessels, known by the name of teleangiectases or erectile tumours, all commence their ravages within the bone.

§ 3. *Anomalies of form.*—The deviations from the natural shape of the bones are many and various; in some instances they are congenital, very frequently they take place after birth. When congenital, they sometimes occur independently and alone, sometimes an apparatus with which the altered bone stands in intimate relation is malformed too; at other times the change of form, whether congenital or acquired, results from some disease in the bone itself, or in other structures. To avoid repetition, I do not enumerate them here; for the most important of them will be more conveniently described amongst the anomalies of the several parts of the skeleton, and of the bones composing them, as well as in the chapter on the Joints.

§ 4. *Anomalies in the relative position of bones, and in their*

connection with one another.—The connection between bones is sometimes unnaturally close and intimate, and sometimes unnaturally loose: when the latter condition is very decided, it is usually combined with some deviation from their relative position, that is with dislocation.

The former state, or that in which bones are bound too closely together, is found, both when their articulation with each other is moveable, and when it is immovable. It is known as *synostosis*, or *anchylosis*, though the latter term is chiefly employed to designate the fixed state of a joint. Synostosis is sometimes congenital, but much more frequently it is acquired.

Congenital synostosis may be the result of an unnatural fusion of points of ossification belonging to separate bones; it is then almost always manifestly prejudicial to the full development of one or both of the united bones, and it accompanies other and more important malformations, such as acephalus, cyclopia, &c.: or it may consist of premature union of bones, which do not naturally unite till various periods after birth: thus the cranial bones are sometimes found united even in the fœtus.

Allied to this, is the case in which certain bones coalesce at some period subsequent to birth, but earlier than that at which their union normally takes place. Thus the cranial bones sometimes unite prematurely with each other, and so do the two halves of the lower jaw, epiphyses with their diaphyses, &c.

Synostosis, when acquired, is either incomplete, that is to say, adjoining bones become bound together by bridges of new bone (osteophytes), which pass over the intervening synchondroses and articular cavities, and enclose them in a more or less perfect bony capsule: or it is complete; the synchondrosal cartilages, or the soft tissues of a joint, having been removed by atrophy, suppuration, &c., the bones are brought into immediate contact with one another, and become conjoined. Vertebrae, the pubic bones, or the bones composing a joint, unite thus with one another; so too does the sacrum with the ossa innominata.

Other bones, also, when brought into permanent and close mutual contact, may become fixed together in the same manner; the ribs, for instance, in cases of lateral curvature.

Synostoses are to be met with under any of the above-

mentioned circumstances, sometimes between single bones only, sometimes at several parts of a skeleton; and sometimes they are almost universal. Phœbus has recently seen and described an example of congenital synostosis, in which there had been a fusion of original points of ossification. There is a very similar case in the museum at Vienna, of congenital fusion of the second and third cervical vertebræ; only it obtains further importance from the fact, that the atlas is also congenitally united with the occiput. In another specimen the bones of the right forearm are continuous with the humerus, without the intervention of a joint. A similar synostosis, and one presenting considerable interest, is that of Nägele's obliquely narrowed pelvis, in which the sacrum is united with one of the innominata.

Anchylosis, in the restricted sense of extinction of a joint, especially that which is acquired, will be considered in the chapter on Joints.

Loosening of the natural connection of bones which are immovably articulated to each other, is denominated *Osteodiastasis*: when the same thing occurs between bones which move upon one another, the result is *dislocation*. In *diastasis* the change produced in the connecting medium depends upon circumstances: it is either stretched, attenuated and loosened in texture, or torn through. Gradually increasing extension leads to the first change, as is instanced by the cranial bones in cases of hydrocephalus, by the bones of the face, when stretched over fibrous polypi, or by the pelvic bones in parturition; while the second is caused by quickly acting force, and is exemplified by disjunction of the sutures when the skull is shattered, by the laceration of the synchondroses of the pelvis in very difficult parturition, or by the separation of the epiphyses in consequence of injury.

Moreover, the occurrence of diastasis is not only favoured by previous disease, especially by inflammatory softening and loosening of the connecting substance, but it may be the immediate result of destructive suppuration of that substance, as is shown by the consequences which the pelvis sustains from the worse forms of puerperal disease.

The subject of dislocations will also be considered in the chapter on Joints.

§ 5. *Anomalies of consistence.*—These anomalies, expansion of the tissue, and so-called softening of bone, on the one hand, and induration on the other, are, essentially, changes of its texture, and of its chemical composition: the latter involve as well the mineral constituents as the animal basement, and they must therefore be treated of amongst the diseases of texture.

§ 6. *Solutions of continuity, and the process by which they are repaired.*—The solutions of continuity in the osseous system, which result from injury, present many varieties. Bones may be laid bare by the removal of their periosteum, and of the soft parts covering them: they may be wounded by more or less sharp penetrating instruments; from whence ensue the various kinds of punctured, incised, and shot wounds, by which the bone is either partly or completely perforated, as well as the wounds inflicted in operations, as amputation, trephining, in the removal of portions of bones, &c. They may be broken, and, as is well known, the fracture may be transverse, oblique, or longitudinal; there may be but one fracture, or several, in the same bone; and sometimes a bone is shivered, or crushed, and the fracture which results is comminuted.

Incomplete fractures or fissures are, for the most part, met with in the skull; as when only one of the compact tables is fractured, or when the inner table is disunited, while the outer remains uninjured.

There is a remarkable form of incomplete fracture, in which a bone becomes bent. It occurs on flat bones, like the skull, as well as on long bones. It is produced sometimes by sudden and violent mechanical force, sometimes by more gentle means, which act through a longer period either uniformly or with intermissions. Its occurrence is favoured by the softness of the bones, which in foetal life and in childhood exists naturally, but in subsequent periods of life is a morbid condition. These inflections of bone are chiefly observed in the skull of the newborn child, as a consequence of the pressure which the head has undergone from the pelvis of the mother, or the forceps of the accoucheur: they may, however, be occasioned by accidental or intentional violence after birth; or they may take place in the bones of the limbs of persons who are affected with rickets

or osteomalacia. They may be brought on by mechanical violence, or by excessive muscular contraction.

Any of these injuries may occur alone, or be combined in various ways with loss of substance : and further, they may be either simple, or complicated with considerable injury, bruising, and laceration of the soft parts, with shattering or splintering of the bone, with the presence of foreign bodies, with excessive degrees of inflammation of the soft parts, with gangrene, necrosis, &c.

In proceeding to the subject of the modes in which the most important injuries of bone are repaired, that by first intention, and that by way of suppuration, or second intention, I must refer, in order that the subject may be thoroughly understood, to what is said below on inflammation, suppuration, and necrosis of bone. The attention which has always been paid to the mode of union in cases of simple fracture has rendered that the foundation, as it were, upon which our ideas, as to the mode of repair in all other injuries of bone, have been based ; and I, therefore, make it, both in its successful and unsuccessful issue, the subject of the following remarks.

Repair of fracture by the first intention.—When the extravasation produced by the fracture of the bone and simultaneous injury of the soft parts, and the vascularity of the soft parts, of the lacerated periosteum, the surrounding cellular tissue, and the adjoining muscles and their sheaths, have in some degree subsided, a reactionary process of inflammation is set up. The soft parts around the fracture, some of which have been injured by the same violence that produced the fracture, and others by the broken bone itself, become swollen and so blended as to constitute one uniform red, firm mass, infiltrated with inflammatory product, which encloses the broken part in a more or less smooth and round, or in an elongated, swelling. In the same manner, the medullary membrane becomes tumid and red ; and, after a time, puts forth a red loose mass, which clings to the broken surfaces of the bone, but soon coalesces with the surrounding soft parts (Breschet's *substantia intermedia*). Thus each of the fractured ends lies in a sort of capsule of swollen soft parts. The innermost layer of the capsule is the periosteum, which, having separated from the surface of the bone to a greater or less distance from the

fracture, is so intimately united with the surrounding soft parts as to be no longer distinguishable: a viscous reddish fluid exuding on its inner surface, fills up the space between it and the ends of the fragments.

Meanwhile, commencing at different distances from the seat of fracture, along the line where the periosteum remains connected with the bone, a reddish, semi-fluid, gelatinous substance exudes, which is greater in quantity the nearer the fracture: it is evidently connected more intimately with the bone than with the periosteum, but the former is entirely unaltered beneath it. Where it adjoins the bone it becomes cartilaginous, and subsequently ossifies: it then adheres intimately to the osseous surface, and if stripped off, leaves it perceptibly rough, and with its pores dilated.

This substance, as it increases in quantity, advances from the point at which the bone and periosteum are connected towards the seat of fracture, keeping close to the inner surface of the capsule of soft parts, and leaving a space between itself and the bare extremities of the bone, which is filled with the reddish viscid fluid before mentioned. At the same time, as it ossifies, it gradually assumes a more definite internal structure. If the fragments of the bone be in favorable position, the masses of callus, as they grow, assume a cylindrical shape, and arrive at the septum formed by the *substantia intermedia*. The septum has already acquired a cellulo-fibrous texture; but now it is gradually removed by absorption, and the masses of callus from the opposite ends of the bone coalesce over the fractured spot. What takes place outside the bone goes on also in the medullary cavity; a substance is effused, which everywhere ossifies and obliterates the cavity of the medulla. These changes constitute what is called the formation of early callus.

This callus gives some firmness to the fracture, and the time occupied in completing it—from thirty to forty days—forms, in a practical point of view, a very important period in the whole reparative process. It is named by Dupuytren the *provisional callus*.

Long before it has reached the state of completeness above described, a later growth, or formation of definitive callus, commences.

The fluid before spoken of as occupying the space between the broken ends of the bone and the callus (and a similar fluid which may be found also between the callus and the soft parts) becomes gradually more firm, receives vessels, and acquires a structure which at first resembles granulations, but at a later period is cellulo-fibrous. A small quantity of a reddish exudation appears beneath it on the denuded ends of the bone, and gradually unites with the granulation-like substance.

As a vascular communication is thus established between the surface of the bone and the surrounding soft parts, a formation of new osseous substance commences all round the fractured ends: it resembles the first formation of callus, but proceeds with less energy.

Both the earlier and the later callus increase in quantity, and at length unite together. They are, however, distinguished from each other by the difference of their texture, particularly by the softness of the second callus, when compared with the fully formed earlier growth. In this manner the broken extremities of the bone are surrounded by an uninterrupted osseous sheath which adheres to them both.

Last of all, in four or five months or more after the injury, the broken surfaces themselves unite within this sheath, though, indeed, the first traces of exuding osseous substance are sometimes perceptible much earlier, beneath the *substantia intermedia*, where it clings to the margins of the fracture. The *substantia intermedia* then disappears, and the fracture is completely repaired. The edges of the fracture are pretty frequently, though not always, distinctly rounded off.

During this consolidation, the remaining swelling of the soft parts subsides, and the medullary cavity begins to be restored at the fractured spot. The Haversian canals, in the mass of bone with which the cavity is filled, are gradually enlarged to such an extent as to render it cellular and areolar instead of solid; by further absorption it is entirely removed, and a new medullary cavity occupies its place. Sometimes a thin layer of the mass remains behind, united at the seat of fracture with the bony substance exuded from the broken margins, and for a long time obstructs the canal.

The callus, which was more or less uneven externally, has by this time become smooth. It is invested with a

fibro-cellular membrane, which consists partly of the old periosteum of the bone thickened, and partly of the exudation poured out by the soft parts: the latter forms a new periosteum, unites into one membrane with the old one, and gradually becoming thinner, at last precisely resembles healthy periosteum.

Although the callus, even when completely ossified, is at first clearly distinguishable from the old bone by the arrangement of its canals and lamellæ, yet in the end it acquires precisely the same characters as the bone. It is more than probable, that in process of time the callus diminishes in bulk; very gradually indeed, but yet so far as the relative position of the fragments of the bone, and its own original size, allow. Thus where simple transverse fractures have united, it shrinks so much as to form at last an inconsiderable elevation, which points out the original seat of fracture. But this is by no means to be regarded as an atrophy of the so-called provisional callus: no such decay, or involution, ever takes place, though it has been asserted by Dupuytren, and admitted by several others after him: there is no provisional callus, in the sense of a material for temporarily uniting, or soldering, the fragments together; and the reabsorption of the mass of bone which fills the medullary canal near a fracture, is to be regarded as one of the phenomena in the progress of the formation of a bone.

The firmness of the union is generally proportioned to the length of time that has elapsed since the occurrence of the fracture.

The process just described, in which bones reunite by first intention, is on the whole the same as that which takes place in injured soft parts. I have now to refer briefly to some points connected with the process, which have long been subjects of dispute; to describe what is observed when fractures unite under other, and especially under less favorable, conditions than those which we have supposed in the foregoing delineation; and lastly, to treat of more important anomalies in the process, such as arrest, and the formation of new or false joints, repair by way of suppuration, and necrosis.

Long as the contrary opinion has been entertained, it is now beyond doubt, that in the formation of callus, no ossification

of the periosteum takes place, any more than of the surrounding soft parts ; but that, in the first formation of callus, the development of the whole osseous mass proceeds from the bone only is not fully ascertained, probable though it be. For, not to mention other facts, bone is sometimes found on the inner surface of periosteum ; and the dura mater particularly, which is virtually a periosteum, frequently presents bony growths on its outer surface, which do not adhere to the bone at all, or do so very loosely, and only at a later period become closely connected with it.

During the whole process of forming callus, the old bone undergoes very trifling change ; and it requires close examination after the removal of the exudation, to discover that the pores on its surface are somewhat enlarged, and that the surface itself is rather rough, in consequence of some of the new matter remaining adherent to it. There is no greater change even when the exudation has ossified. When the formation of callus is complete, and the fragments have reunited, the bone sometimes shrinks, and becomes palpably thinner, and its cavity smaller than before.

When only one of two adjoining bones is broken, as in the forearm or leg, the uninjured one takes part in the process of forming callus. Osseous matter is exuded by it near the fracture, which unites with the callus of the broken bone ; for just as the *substantia intermedia* disappears when the broken surfaces of the bone unite, so the periosteum covering the callus of the uninjured bone is absorbed, and the two growths of callus coalesce. But still more frequently is this the case when both bones of the forearm or leg are broken, or whenever there is a fracture of two or more adjoining bones, such as the ribs. In fractures in the neighbourhood of joints, fears may even be entertained, lest union between the articular ends of the bones be occasioned by the callus.

Long oblique fractures involve a mass of soft parts in the reactionary process, and are attended by the formation of a quantity of callus, proportioned to the extent of the fractured surfaces. So, too, the greater the displacement of the fragments, the greater, and at the same time the more misshapen, will be the swelling of the soft parts, and the subsequent callus. The same occurs when the fracture is comminuted.

The great extent to which fragments, when displaced, are denuded occasions a difficulty in the formation of the secondary callus, and retards the process of repair; but in all essential particulars the process is the same. The callus encloses the fragments, and generally forms a bulky mass, which connects the opposite surfaces of the bone together. The medullary cavities, at first open, become blocked up with callus, which unites intimately with the swollen soft parts around; but gradually opening again, they become continuous with a new medullary cavity, which forms in the callus. Sometimes even when contiguous walls of the bone are firmly consolidated together, they and the intervening callus are absorbed, and the continuity of the original tube is restored by means of a new transverse or oblique canal. A remarkable analogy to the mode in which bone is originally developed is observed in the universal tendency to form medullary cavities in the interior of all large masses of callus, as in exostosis, and the more bulky osteophytes.

Separate fragments unite within the callous enlargement in more or less favorable positions.

The surface of large masses of callus is marked with grooves in which tendons or large vessels lie; and sometimes they are even perforated in various directions by small canals which those structures traverse.

Of arrests of the growth of callus in general, and of new joints in particular.—The modes and degrees in which the formation of callus may be arrested, are very various. The quantity formed may be insufficient for its purpose, or there may be none at all: it may undergo the change which is incident to it very tardily, and not be ossified till a very late period; or may be imperfectly, or but partially, ossified: or the exudation, instead of becoming cartilaginous and bony, may assume and retain an apparently ligamentous structure. Such arrests may take place on both fragments, or predominate on one: and further, the anomaly may extend to both the first and second growths of callus, but usually it occurs in the latter only. In such cases, days and even weeks after the occurrence of a simple fracture, neither the bone nor the soft parts around it exhibit well marked, or indeed any traces of reaction; and if the fracture should at last unite, it does so by the way of suppuration. In other cases, the growth of callus may be

insufficient, the masses first formed may meet each other only at a few points, or may even not meet at all; as is the case when there is great displacement of the fragments. The secondary callus may not unite completely with the primary, and may remain soft and cartilaginous, or there may be too little of it formed, especially at the fractured extremities of the bone; in which case, its metamorphosis may be arrested or anomalous; or there may be no callus formed at that part at all.

It is in the last-mentioned circumstances that the cause is found for the formation of new, or false joints. (*Articulus novus, spurius, præternaturalis; pseudarthrosis; articulation surnuméraire* of Bécclard.)

The unnatural joints, which result from fracture, are of two different kinds: one more or less resembles a synchondrosis; the other is like a diarthrosis, and is accordingly, in its proper sense, a new joint.

In the former case, the fractured ends of the bone are held together by a ligamentous tissue. Either a disc of ligament, the thickness of which may vary, is interposed between them, and allows of but little movement; or, as occurs when there has been loss of substance, either from injury, from considerable absorption of the fractured ends, or otherwise, ligamentous bands connect the fragments, and allow them to move freely on each other. The connecting substance appears to be nothing but the *substantia intermedia* mentioned above, which, as the formation of the secondary callus has failed, or been insufficient, remains in its first state.

In the second case, a ligamentous articular capsule is formed, and is lined by a smooth membrane, which secretes synovia: the fractured surfaces adapt themselves to each other, and become covered with a layer of tissue, which is fibro-ligamentous, or more or less fibro-cartilaginous, or which resembles, and sometimes (*Howship*) really is, cartilage: they may articulate immediately with one another, or may have between them an intervening layer of ligament, which corresponds to an interarticular cartilage; and their movement upon each other is more or less free, according to the size of the articular capsule, and the form of the articulating surfaces. These last are sometimes horizontal and smooth; they glide over each other, and allow of restricted

motion : sometimes one surface becomes convex, and the other concave : sometimes both are rounded off, and lying within a capacious articular capsule far apart, they come in contact only during particular movements. The articular capsule is the product of the inflammation of the soft parts : the cartilaginous layer, which covers the ends of the bone, is secondary callus arrested in its metamorphosis and converted into a fibroid tissue : the other ligamentous cords, which are sometimes present, and the structures resembling an interarticular cartilage, are remnants of the *substantia intermedia*.

Both forms of new joint, but more particularly the synchondrosal form, have an analogue in the lateral new joints sometimes found between the masses of callus which are thrown out around two adjoining fractured bones. In the forearm and leg, and between the ribs, for instance, new joints are sometimes met with between the masses of callus after fractures have united.

Between that kind of new joint which constitutes a firm synchondrosis, and that which as nearly as possible resembles a natural diarthrosis, there are numerous gradations.

The circumstances which arrest the growth of callus generally, and give rise to the formation of false joints, are as follow : advanced age and senile atrophy of the bones ; emaciation in consequence of disease, or loss of the fluids ; cachexia generally ; diseases of the bones in particular, such as rickets, osteomalacia, too severe inflammation, suppuration, caries, and necrosis at the broken spot ; paralysis, and similar affections (on which subject reference may be made to Roechling's experiments on animals) ; pregnancy ; any improper bandage which stops the access of the fluids to the part (a circumstance which is explained by Brodie's experiments of tying the crural artery in animals, in which the femur was broken) ; inquietude of the limb ; considerable displacement of the fragments, and the occurrence of the fracture within the capsule of a joint.

But these conditions do not always put forth their power of arresting the formation of callus and the repair of fractures ; certainly they do not always act equally. Thus the fractures of bones affected with rickets or osteomalacia are not very unfrequently united by a mass of callus, which not only is sufficient to repair the fracture, but even has a more perfect

internal structure than the other bones : fractures very often unite at every period of pregnancy; and the neglect of quietude is unquestionably rather a grave impediment to the reunion of fragments in proper position than to the formation of callus and the repair of a fracture generally.

Fractures within the capsule of a joint require more particular notice. It is a fact ascertained from much experience, and now established as a rule, that fractures within the capsules of joints very rarely unite completely : the fragments become bound either firmly or loosely together by a ligamentous apparatus ; or, their surfaces becoming eburnated or covered with membrane, they form an articulation with each other within the old joint. Many reasons have been assigned for the great deficiency in the formation of primary callus around these fractures, as well as for the arrest of the growth of secondary callus ; but which of them is to be regarded as the true and the universally applicable one is not ascertained. As fracture of the neck of the femur is the principal instance of the kind, and is that which has led to all the investigations that have been instituted on the subject, I shall enter more particularly into the consideration of it when treating of Diseases of the Bones of the Lower Extremities.

Union of fractures by suppuration.—Compound fractures unite in a different manner from that by first intention ; yet the repair by suppurative inflammation, in its essential particulars, has been far too little investigated. It is analogous on the whole to the repair by first intention, certain stages of the latter always occurring in the course of it ; only, as must be obvious, the repair is effected with more difficulty and at a later period, and sometimes is never completed.

In this as in the other process, a capsule of soft parts forms around the broken ends of the bone, but the inflammatory product contained within it is pus, just as in any wound which may exist at the same time in the soft parts, and the capsule being lined with a grayish-red, translucent, jelly-like, granulating layer, which is covered with pus, is in fact a closed abscess.

The early callus, as in union by first intention, appears as a gelatinous exudation, which subsequently becomes a cartilaginous, and then a bony stratum. It springs from the bone, at the part which has remained covered by periosteum ; and then,

keeping off from the denuded ends of the bone and from the fracture itself, it advances on the inner wall of the capsule towards the broken part, the ossifying cartilage being developed from the granulating layer.

The broken ends of the bone, so far as they are denuded of their periosteum, are washed in the pus: they lose their natural colour, and look bleached and dull white, but are otherwise unchanged—even at the surfaces and margins of the fracture.

It is not usual to see any plastic exudation in the open medullary cavity: the fractured surfaces are everywhere washed in the pus: the internal surface of the bone—that which faces the medullary cavity—appears dull white and dead to a greater or less depth on one side, or for the greater part, or the whole, of its circumference: the cells and spongy tissue are in the same state; and the medulla at that part is collapsed, soft, and discoloured, and is dissolving in the pus. Beyond the confines of this change, however, the medulla is swollen and reddened, and if the necrosis have not extended all round the bone, it protrudes, as it does in the process of union by first intention, beyond the fractured surfaces.

Now, it is more particularly the growth of secondary callus which is late in commencing, which very often suffers more or less considerable interruptions in its progress, and which differs most from that which is formed in union by first intention. The ends of the bone being washed in pus, and thus kept in contact with a fluid incapable of organization, die: and the extent of the necrosis, whether it shall be superficial, shall be confined to the inner layer of the bone, or involve its whole thickness, is unquestionably determined by the extent to which the periosteum is stripped off, and the medullary membrane destroyed. As soon as the necrosed part has exfoliated, granulations appear on the bare surfaces and margins of the fragments, and become the basement in which the new bony substance, or secondary callus, is deposited.

It is by the very slow manner in which the exfoliation of the necrosed bone takes place, that the formation of the secondary callus is delayed: and as not unfrequently the powers of the system are almost exhausted before it is completely formed, it is often produced in insufficient quantity, or arrested in

its perfect internal development, that is, in its ossification. Moreover, as soon as the exfoliation and entire removal of the necrosed piece are effected, the inflammation ceases, and a great part of the granulations which were exuded for the purpose of producing new bone, goes to form on all sides a cellulofibrous, ligamentous, and cicatrix tissue: hence it is, that the repair of fractures in this manner is so often incomplete, and is attended with so extensive and permanent a loss of substance. Whatever the condition of the early callus, whether it be abundant in quantity and thoroughly organized, or otherwise, the granulations supply an inadequate substitute for the bony substance which has been lost by exfoliation: instead of changing into cartilage and bone, they become converted into fibroid tissue; and thus the repair which ensues is attended with shortening, with disfiguring cicatrices, or with an artificial joint.

Repair of the bendings and fissures of soft bones.—When the bones of children or of persons affected with rickets have been slightly and gradually bent, and the bony tissue and periosteum have been stretched without suffering a breach of their continuity, they are gradually restored to their natural direction without giving any sign of reaction. And those injuries also in which the bones of children are rapidly and violently bent, are easily repaired. But when bones are bent to an angle by a greater and more sudden force, and a real, though not always perceptible, solution of continuity takes place, whether it be on the one side a tearing asunder, or on the other a crushing, of the outermost layers of the bony tissue, the injury is repaired like a fracture by first intention. When bones affected with rickets and osteomalacia are bent in this manner, the callus generally continues in a soft half-cartilaginous state, and does not obtain its perfect internal structure till the disease is cured. To this, however, there are exceptions, for bones affected with these diseases, when bent and partly fractured, and also when broken quite through, are sometimes reunited by bony callus; and it is not till after it has reached a certain stage of development, especially in osteomalacia, that the callus undergoes the peculiar metamorphosis.

Repair of injuries of bone complicated with loss of substance.
—The mode in which wounds of bone combined with loss of

substance are repaired is, on the whole, the same as that by which fractures unite. Under favorable circumstances it is effected by the first intention, and the osseous mass exuded from the surfaces of the wound in the bone serves not merely to reunite the bone, but also to supply the place of the part which has been lost. This is true of loss of substance as well of one bone as of another, and in whatever degree, or in whatever form it may have occurred. Irrespectively of unfavorable general conditions, it may be said that the greater the loss of substance, and the more the repair proceeds by way of suppuration and granulation, the less complete will be the reproduction.

Hence it happens that injuries of this kind are followed by permanent loss of more or less of the substance of the bone, and that in long bones shortening, or a false joint is produced.

Wounds of the skull made with a trephine are extremely seldom closed by bony substance altogether, but the circumference of the opening mostly exhibits a growth of bone which may be compared to the two formations of callus. It proceeds from the surfaces of the compact tables, as well as from the surfaces and margins of the wound; but it is insufficient to close the opening, and the defect is, and continues to be, for the most part supplied by a ligamentous (fibroid) plate, which adheres closely to the dura mater on the one side, and to the pericranium on the other: the trifling amount of (secondary) callus which proceeds from the surfaces of the wound juts into the substance of this plate.

The adjoining part of the wall of the skull is not unfrequently at the same time considerably attenuated, so that the fibroid layer which closes the opening is continuous with a margin of bone, towards which both surfaces of the skull are bevelled off.

In some cases true bone is developed in this fibroid plate. It assumes the form of needles and small plates, and, gradually becoming identified with the callus which is growing inwards from the margin, it at length effectuates the closure of the opening by bone. Similar bony growths are met with, in false joints, in the ligamentous structures by which the fragments are connected together.

The way in which the wounds of bone made in amputations

are healed accords with what has been described above: the medullary canal closes, the stump becomes rounded off, and unites with the soft parts and their cicatrix by an intervening cellulo-fibrous tissue, which supplies the place of a periosteum. If the inflammatory process should lead to suppuration in the bone, and still more, if suppuration take place in the periosteum and medulla, necrosis ensues to a corresponding extent; and when the dead piece has exfoliated, the cure is effected by way of granulation.

Under such circumstances, the condition of the stump is sometimes unfavorable: the callus may be insufficient in quantity and density, and therefore incapable of enough resistance: the stump may be attenuated and end in a point; or, on the contrary, the callus may grow from it exuberantly in the form of some of the various osteophytes.

Repair of injuries in which bone is denuded of its soft coverings.—There is no question that injuries of this kind are repaired by first intention. The soft tissues and the bone together furnish an exudation which becomes organized at one part into a layer of callus, and at another into a cellular or cellulo-fibrous tissue; and it will be observed, that the connection between the two new products is considerably closer than that which exists between bone and its periosteum in their normal condition. But in the unfavorable circumstances under which these accidents occur, and in which they remain, for a more or less lengthened period, until the arrival of surgical aid, such injuries are more frequently repaired by suppuration and granulation, after the exposed layer of the bone has exfoliated. Not unfrequently, indeed, they lead to a fatal termination, by the extensive suppuration in the soft parts, and the necrosis of the bone, which, like other injuries of bone complicated with wounds of the soft parts, they set up.

§ 7. *Diseases of Texture.*—Although diseases of bone generally, and those of its texture especially, have been the object of much valuable investigation, both clinically and anatomically, yet our knowledge of them is still very defective; and perhaps nowhere amongst the diseases of the solid organs is the need of chemical research keeping pace with anatomical inquiry more perceptible than in the subject now before us.

And another circumstance, which renders it extremely difficult for the pathological anatomist to deduce his single results from numerous investigations, is the want of accurately distinguishing between different affections of bone, according to their local characters, as well as to the general symptoms, on the living patient; for regard is usually confined to syphilis, scrofula, and particularly to gout, when subsequent anatomical examination discloses changes of an entirely different nature.

1. *Congestion of bone, Hemorrhage.*—Bones, like every kind of soft part, are subject to congestion, though, on account, probably, of the little attention which is generally paid to them in examinations after death, changes of their vascular condition are seldom noticed and estimated. Congestion is most frequently observed in the bones of the skull, the vertebral column, and the spongy articular extremities of long bones. In new-born children, and during childhood, considerable congestions of the cranial bones are met with: passive and mechanical congestions of the vertebræ, especially of the lumbar portion of the column, occur, even in advanced life, when the circulation through the ascending cava and vena portæ is impeded: and cases of osteoporosis, rickets, &c., are accompanied by extreme congestion. There is no question that habitual congestions not unfrequently lead to hypertrophy of bone, especially in the form of induration: in cases of atrophy, where congestion coexists with expansion of bone, that is, with enlargement of its Haversian canals and cells, it may be produced by the wasting of the tissue of the bone.

Hemorrhage takes place from bone under various circumstances. The vessels of bone, periosteum, and medullary membrane pour out their blood when torn in the various injuries which happen to them. Occasionally very considerable bleeding takes place under the periosteum, in the spongy tissue, or in the medullary cavity, from the exposure and corrosion of vessels of various sizes, by caries. But the most interesting cases are those in which spontaneous hemorrhage, resulting from extreme congestion, originates from the delicate vessels that pass between periosteum and bone, and ramify in the grooves or half canals on the surface of the latter. The principal instance is that met with on the cranial bones of the new-born child, which is known by the name of Cephalhæmatoma.

I shall have to advert to it again amongst the Diseases of the Bones of the Skull, where it can be more conveniently described.

2. *Inflammation of bone.*—Inflammation of bone (ostitis) is sometimes evidently the result of external causes, of various injuries, for example, most of which have been already enumerated, of concussion of the bone, or of cold: sometimes it arises from internal conditions, as when some constitutional affection, whether syphilis, the mercurial cachexia, scurvy, gout and the like, or an exanthematous process, fixes itself in a bone. But the etiology of inflammation of bone is a subject which requires, more than many others, to be cleared up.

Moreover inflammation of bone is frequently a secondary disease, propagated from neighbouring tissues, especially from the periosteum.

It is sometimes an acute inflammation, especially when produced by external injury; very frequently it is chronic, and is almost always so when it arises from any constitutional affection. It is sometimes confined to one bone, or to one circumscribed spot on a bone; sometimes it attacks several bones, or most, or nearly all of them, not perhaps all at once, but one after another in more or less rapid succession. At one time it affects the outer layer of a bone, and is combined with periostitis; at another the inner strata, when it is associated with inflammation of the medullary membrane: the accompanying inflammation of the periosteum and medullary membrane may be an original part of the inflammation, or a later addition to it. Lastly, there is a third case, in which a bone is inflamed in its whole thickness: in some instances it is so from the first, in others the inflammation reaches that extent later in its course.

It is situated sometimes in compact substance, in the compact portion of a bone; sometimes in spongy substance, in spongy bones, and spongy parts of bones; and, external causes being excluded from consideration, the selection of its seat depends in a remarkable manner on the constitutional affection which gives rise to it, a peculiar preference being manifested sometimes for one portion of the skeleton, sometimes for another, and sometimes for particular bones. Inflammations of bone vary much, and, in a practical point of view, materially

in the degree and nature of the inflammatory process; and exhibit it first in the composition of their product (the exudation), and then in their consequent terminations. It would be inconsistent with nature, and in fact impossible, in an anatomical delineation of inflammation of bone, to make a broad division of it into acute and chronic; I shall, therefore, be careful only at the proper points to mark the transitions of one into the other, and the characteristics by which they are distinguished.

A very moderate degree of inflammation, in the outer lamella of a bone for instance, produces a gelatinous, dark red, exudation, which gradually changes its colour to bluish red, yellowish red, and reddish white, and at length becomes quite white: at the same time passing from its original gelatinous condition, it forms a coagulum like white of egg, then becomes a soft, flexible cartilage, and, finally, reddish-white, succulent bone. In this state it invests the bone, and constitutes, according to its quantity, either a white, porous, and scarcely perceptible film, or a thicker layer that resembles fine felt or velvet. The periosteum appears at first injected, bluish red, infiltrated, and decidedly swollen, and generally has but a loose connection with the exudation; for the latter, especially after it has ossified, adheres somewhat closely to the bone: sometimes, however, when the periosteum is peeled off, part of the exudation comes away with it. There is no change in the bone till the process is advanced, and then its grooves and the pores for its vessels are manifestly widened. The ossified exudation afterwards unites with the surface of the bone, and either forms uninterruptedly an addition to the thickness of the compact wall, or is connected with it by a layer which remains spongy (diploetic). In some of the thicker layers of bony exudation, occasional voids of various dimensions are met with, which are filled with a vascular tissue containing medulla: they may, on the macerated bone, be easily taken for the losses of substance produced by caries; but without doubt they are merely the result of absorption in bone already formed, and are analogous to the formation of cancellous tissue, and a medullary cavity in callus. (Compare with this and with the following, what has been said on the subject of the osteophytes.)

The principal opportunities of seeing this process are obtained in the neighbourhood of more intense spots of inflammation, and around caries.

The inflammation may recur in the exudation at any period of its ossification, and lead to a corresponding increase in the size of the bone.

There are other inflammatory processes, some of them more acute, which return from time to time, and appear to be of a specific nature. Like those already described, they extend sometimes to several bones, and they deposit abundant exudations, which may assume the form mentioned above, or the various other shapes delineated in the section on the osteophytes: the periosteum, at the same time, becoming hypertrophied, acquires a fibro-lardaceous, callous structure, and sometimes an enormous thickness.

An inflammation of this kind may be often observed beneath chronic ulcers on the inner surface of the tibiæ. The periosteum and adjoining cellular tissue, having been converted into a lardaceo-callous substance, form the base of the ulcer, and cover a luxuriant growth of curled bony plates, like madreporæ, which are arranged perpendicularly upon the bone: the periosteum sends processes between, and forms sheaths around the separate plates. A villous, or a spavined and laminated, osteophyte is usually seen in the neighbourhood, and hence, as the new tissue becomes indurated, a circumscribed portion of the bone is increased in bulk.

When the inflammation is seated in the inner lamella of a long bone, or in the diploetic substance, it pours forth its product on the inner surface of the medullary tube, or on the walls of the cells of the spongy substance; and the tube becomes narrowed, and the spongy substance condensed. The process of exudation very often occurs on both the outer and the inner lamella of a bone together; and sometimes the intermediate substance also shares in the process, and the ossifying exudation, deposited on the walls of the Haversian canals, produces induration (sclerosis) of the bone.

Besides these there are, no doubt, inflammations of bone, especially such as are slight in degree, and chronic in their course, which give rise to products that become organized in various other ways. Some change into osseous substance, the

texture of which deviates from that of healthy bone ; while others form fibroid, or cellular tissue, or a substance which resembles the jelly of spongy bones. Such products occasion a loosening and expansion of the bone proportioned to their quantity ; and many of the osteoporoses, which are attended with increase of the volume of the bone, are, no doubt, due to such processes of inflammation, or as they are called, irritation.

A high degree of inflammation in bone leads to the effusion either of a fibrinous product, which more or less rapidly softens ; or of a purulent exudation, which varies in fluidity, according to the quantity of serum it contains, and is yellow and frequently tinged by an admixture of the colouring matter of the blood, and of blood itself ; or, lastly, of a greenish or brownish discoloured sanies. There are some striking instances of this kind of inflammation, which run their course very rapidly : they occur not only after injury of a bone, especially after concussion, but also in consequence of cold ; and they are associated with endocarditis and several other exudative inflammatory processes. The periosteum in these cases is loose and moveable to some extent over the bone, the exudation being poured out beneath it : in well marked cases, it becomes loose all round the bone, and distended into a fluctuating sac, which contains a large quantity of the exudation. The tissue of the periosteum is loosened and infiltrated : the bone is of the same colour as the exudation, and has accordingly a dun, a dirty yellowish, or a greenish or reddish appearance, which results from all its spaces being occupied by the exudation. The exudation is deposited in greatest quantity in the cancellous structure ; but when the compact tissue is minutely examined, the Haversian canals are found to contain it too. The surface of the bone, especially when the exudation is sanious, appears rough, that is to say, its outermost layer is eroded, and the loss of substance is produced by the solution of its tissue during the process of exudation itself, and by contact with a product which exerts an absolute dissolving power. The walls of the Haversian canals exhibit similar loss of substance, and are rough and eroded, or completely perforated. The cells of the cancellous structure show it still more clearly, and the membrane which covers its cells and

network is opaque, dull, and discoloured like the exudation, and is easily torn. It is this form of *ostitis* which, if it do not prove fatal by its coexistence with other exudative processes, very commonly puts life in the greatest danger, or actually destroys it by leading to absorption of the purulent and sanious matter into the circulation (the coats of the veins probably being dissolved in the exudation around them), and by *metastasis*. When the case is favorable, necrosis of the diseased bone, or portion of bone, is inevitable.

But inflammations of bone, which are accompanied by the production of pus and sanies, are more frequently chronic. The suppurative inflammation mostly occurs as a consequence of complicated injuries of bone and of necrosis: the chronic inflammation with an ichorous product, arises from internal causes, sometimes commencing spontaneously, sometimes being excited by injury to the bone, and sometimes, under the influence of the internal causes just alluded to, being an early or a late degeneration of the suppurative inflammation. It produces loss of the substance of the bone by ulceration, and constitutes *Caries* (*Vereiterung*—*Beinfrass*).

In suppurative inflammation, especially in cases of considerable injury of bone, exposure, for instance, for a lengthened period, there very commonly takes place, in the benumbed tissue, a visible exfoliation of a layer of bone of various thickness. When the necrosed portion is very thin, exfoliation is rightly assumed to be going on imperceptibly by the separation of small and scarcely discernible particles. But there are several cases in which symptoms have been ascribed to necrosis and insensible exfoliation, merely as it appears, for the sake of the theory, and in which no such process occurred. The circumstances were in reality more favorable; for as, when suppuration in its most benignant form takes place anywhere, the first secretion of pus is attended by some breach of substance—by some solution—of the tissue in which it occurs, so is it in these cases. The softening which many observers have adduced as a constant phenomenon in the suppuration of a layer of bone, must be regarded as such a process of solution: a portion of bone disappears, and the exudation beneath it, like that beneath exfoliated bone, becomes organized into granulations, which spring from the tissues lining the Haversian

canals. This view is supported generally by the process of sanious destruction, which is allied to the suppurative, and is only distinguished from it by the relatively greater amount and the progressive increase of the solution; while it is upheld more particularly by the state in which a bone is found when this peculiar loss of its substance is the consequence of an acute inflammation attended by the production of pus or sanies, or when it results from caries: and lastly, it is further borne out by the condition of a sequestrum: but this is a subject to which I shall revert when speaking of necrosis.

A spot of suppuration in bone is always skirted by an inflammatory process, which leads to an exudation of bone. If the affected part be the outer layer, an osseous exudation is found not only encircling the suppurating spot, but also on the inner table of the bone, and *vice versâ*. When suppuration takes place in spongy bones, this process occasions so much condensation, that in a few cases an abscess becomes inclosed within a capsule of compact bone. This capsule is lined by a cellular membrane which is richly supplied with vessels, and it resembles an abscess in the soft parts inclosed within callous walls. Abscesses of this kind have been pretty frequently observed in the extremities of the tibia (Brodie, Mayo); and on a few occasions they have been met with in the compact substance of the shaft of that bone and of the femur (Arnott).

Having hitherto treated of those terminations of inflammation in which bone is increased in volume and density (sclerosis, which is equivalent to induration in the soft parts), and in which suppuration ensues; I am induced by the importance of the subjects to bestow separate sections upon the consideration of caries—chronic inflammation with production of sanies—and necrosis.

3. *Ulceration of bone,—Caries.*—This disease corresponds to ulceration in the soft parts. It is sometimes the immediate result of an inflammatory process of low type (dyscrasia) the product of which exerts a solving power upon the bony tissue: the scrofulous and syphilitic ulcerations of bone are of this kind. Sometimes it arises out of simple suppuration in a bone in consequence of local or general (internal) causes. It is, moreover, frequently set up by ulcerative processes going

on in adjoining soft parts; a frequent instance of which is presented by the caries of the articular ends of a bone, which ensues upon disorganization (*Verjauchung*) of the soft tissues of a joint. Lastly, it results also from the softening and ulcerative inflammation of morbid growths in bone, such as tubercle, cancer, &c.

Caries is sometimes situated at the surface (*caries superficialis, peripherica*), and sometimes originates in the interior of a bone—in its medulla (*caries centralis, profunda*). In its extent it may be total or partial: it may involve a whole bone, as one or more of the vertebræ, of the carpal or tarsal bones, or the whole of a finger or toe; or it may attack a portion only of one of the larger bones, such as the end of one of the long bones composing a joint, or a circumscribed spot on the shaft of a bone.

Though it chiefly affects spongy bones and parts of bones, it is not altogether rare in the compact tissue; indeed, certain forms of dyscrasia establish their ulcerative inflammation by preference in that tissue: generally speaking, we may say that there is no bone which may not be the seat of the disease. It is most frequently met with in young persons as a scrofulous affection.

It may come on, whether the tissue of the bone in which it occurs be in its original healthy state, or have been previously diseased; it may occur, for instance, in a rickety bone.

Its course is generally chronic; but in the extensive devastations which it commits, and the fatal exhaustion which it sometimes produces within a short period, it frequently exhibits the character of an acute disease. It often threatens life, moreover, less by its own progress than by exciting inflammation in neighbouring important organs; it does so, for example, when it occurs in the skull.

An ulcer in bone presents numerous varieties corresponding with the kind of constitutional affection which gave rise to it. I shall, however, first treat of the process of ulceration in bone generally, without reference to its varieties, as there will be an opportunity in another part of detailing the characters and differences which the ulcer obtains from the several processes of dyscrasia in which it originates.

The appearances presented by an ulcerated bone when

examined in the recent state, vary according to the progress which the disease has made ; and in every stage of the affection its characters are far better marked in a spongy than in a compact bone.

When caries is superficial, the compact bone is found covered with ichor, and rough, as if it had been gnawed : this appearance is given by the unequal loss of substance which the outer lamellæ have sustained. The Haversian canals are enlarged, but not uniformly : the tissues contained within them form in part a disorganized soft and shreddy mass, infiltrated with ichor ; or spongy granulations which easily bleed, grow from them luxuriantly, and advance outwards over the rough surface of the bone, whilst internally they partially or completely fill the enlarged Haversian canals. In both cases the bone appears porous or cancellous, but its colour differs in the two : in the former, it is discoloured by the contents of the Haversian canals ; in the latter, it obtains various tints of red from the colour of the granulations.

When caries affects cancellous tissue, the bone acquires a livid red colour, especially if the granulations be at all abundant ; it becomes soft, resembles a mass of flesh traversed by a delicate and brittle bony skeleton, and is easily cut with a knife, or yields to light pressure with the finger : lastly, it becomes swollen.

In cases of central caries, the swelling sometimes produces expansion of the bone, especially if it be a spongy bone, for the thin wall gives way and becomes distended.

The loss of substance which the bone sustains is occasioned by its solution in the sanious product which is effused by the inflammation into the Haversian canals. These canals enlarge in all directions, though not uniformly, and contain in different proportions, on the one hand, sanies and the soft parts which naturally fill them, discoloured and disorganized (*verjaucht*) ; and on the other hand, granulations. It is thought by Delpech and Berard, Pouget and Sanson, and by Mouret, that a peculiar fatty matter is generated in carious bones : Mouret differs from the others, however, in believing that the organic principle (the gelatinous portion) does not disappear from the bone.

The sanies produced by the bone is an acrid fatty fluid,

itself discoloured in various ways, and which, as is well known, blackens silver probes and linen. It almost always contains small particles of bone, discoloured and brittle, which look as if they had been calcined, and are, in fact, loosened remains of the bony tissue, which is being destroyed. They are, without doubt, minute portions of necrosed bone; for in every form of caries, small imperceptible particles of bone die and are cast off. More rarely it happens, that necrosis of a larger piece of the ulcerating bone takes place (caries necrotica). In that case the portions of bone die sometimes without partaking at all in the inflammatory process, and simply from the access of their fluids being cut off by the carious destruction which is going on around them; and sometimes they die from the inflammation and disorganization.

Whilst this disorganizing process (Jauchung) is going on in the bone, more or less of the adjoining osseous tissue and soft parts are always inflamed to a greater or less distance. The inflammation is sometimes chronic, and the soft parts become infiltrated with a gelatinous, or gelatinous and lardaceous product, and indurated: at other times it is acute, and leads to suppuration and ulceration. The periosteum, and the ligamentous tissues connected with the bone, are, of course, involved in this change in the soft parts. The mode in which the ulcer in the bone opens externally, varies according to circumstances: sometimes one large abscess is formed; at other times, one or more straight or tortuous, single or branching, long canals (fistulæ, sinuses), either lead directly outwards, or not unfrequently pass to very remote distances; the orifices of the sinuses are usually marked by rather a hard margin, which surrounds them like a rampart.

The carious bone, when macerated and dried, looks rough, and as if corroded: from being perforated in various ways by the unequally-enlarged Haversian canals, it has a spongy, porous, worm-eaten appearance; the cells of its cancellous structure are enlarged; its walls and network are attenuated or demolished; and hence it is lighter than natural, discoloured, expanded, and very brittle.

New osseous substance, which assumes the form of some of the different osteophytes, is sometimes deposited around the ulcerated spot, both on the surface of the bone, in its medullary canals,

and in the cells of its spongy substance. And bone is deposited not only on the diseased bone, but on others also which are near it.

In other cases the neighbouring bones are found in a state of rarefaction (osteoporosis), of areolar expansion, combined with hypertrophy, or inflammation of the soft parts of the bone, and, at length, of atrophy of their tissue.

Caries will heal, even in cases where it has committed great devastations, by a change of the ulcerative into a healthy suppurating and granulating process. The subsequent reproduction of bony substance is small in proportion as the amount of destruction has been great, and hence there will be more or less deformity, as well as variety of size, in the cicatrix.

Caries, as has been partly mentioned already, and will also be further pointed out hereafter, must be carefully distinguished from several other losses of substance in bone.

4. *Necrosis (mortification of bone).*—Necrosis in bone corresponds to mortification in the soft parts, more particularly to dry gangrene, or mummification. It has in general a less serious character than the latter, inasmuch as by the application of appropriate artificial remedies, it very commonly, though slowly, gets well; and is only fatal in the few cases in which the strength of the patient is exhausted by the excessive secretion of matter that takes place, for the purpose of removing the dead piece of bone. Necrosis sometimes arises from external causes, such as injuries of various kinds, by which the bone is shaken, crushed, or laid bare, from the influence of severe cold, heat, &c.; and sometimes it is developed, as is said, from internal causes, amongst which various kinds of constitutional disorder are enumerated, especially scrofula, syphilis, the state of constitution resulting from the abuse of mercury, gout, scurvy, &c., and the cachectic state succeeding acute exanthemata, especially variola and measles. An internal cause of this kind, in producing necrosis, may do so, not only by exciting inflammation and suppuration of the periosteum or medullary membrane, but also, as is extremely probable from analogy, by leading to inflammation of the bone.

Necrosis may affect either the whole of a bone (necrosis totalis), or, which is more frequent, only a part of one, (necrosis partialis.) In the latter case the outer lamella may

be alone involved (necrosis externa superficialis), or only the inner layer of a cylindrical bone, or diploetic substance of a broad bone (necrosis interna, centralis); or again the whole thickness of a bone, within certain limits, may be necrosed. But it is very rarely that a necrosed piece admits of its whole extent being so accurately defined; that which at one part includes the whole thickness of a bone, runs out at its extremity into a superficial necrosis. Internal necrosis, too, occupies a bone very unequally, and at some parts frequently extends nearly through its whole thickness.

Moreover, the boundaries of a piece of dead bone are irregular in every direction; its margins are notched and sinuous; and its thickness especially, if the piece be peripheral or central, is very unequal in different parts.

The less vascular compact bones are those which are chiefly liable to necrosis; and of such the shafts of the long bones, more particularly the tibia, and after it the femur, humerus, ulna, radius, and fibula, and the bones of the skull, are most affected. Unlike caries, it rarely occurs in spongy tissue. Necrosis of the long bones very commonly terminates at their cancellous articular extremity, or at the junction of the epiphysis with the shaft. Every period of life is subject to it, though it is most frequent in young persons; and in them it occurs as scrofulous necrosis, or necrosis based upon a scrofulous constitution.

Necrosis sets up an active inflammation in the adjoining healthy bone and surrounding soft parts, which goes on to suppuration, and continues until the dead piece is removed either by nature or art. Separation in the former manner is very seldom completed, for the suppuration rather exhausts and destroys the patient. The matter discharges itself externally by one or, more commonly, by several ulcerated sinuses.

The purpose designed in the suppurative inflammation is to separate, and finally to throw off, the dead portion of bone, which then obtains the name of *sequestrum*. The necrosed piece is at first distinguishable, to a certain extent, from healthy bone by its bleached and somewhat discoloured appearance, but its boundaries are at that time indistinct, inasmuch as the discoloration of the dead part blends gradually with the colour of the healthy bone.

All round the necrosed portion, that is to say, at its margins, and at the part where its surface is opposed to that of the healthy bone, the latter undergoes a gradual expansion or rarefaction of its tissue by the enlargement of its Haversian canals, assumes a rosy colour, and becomes succulent. It acquires gradually an areolar structure, and is thus more rarefied : at length it disappears altogether, and a red soft spongy substance, a layer of granulations, occupies its place. This change is produced by an inflammatory process, which gives rise to suppuration and granulation : the bony tissue, beginning with the Haversian canals, is dissolved by the matter secreted within them, while the granulations which shoot forth at the same time, fill up the enlarged canals. The immediate result of this process is the formation of a furrow of demarcation which encircles the margin of the dead bone, and is filled with granulations ; and so far as the process is completed on that surface also of the living bone which faces the dead, so far is the sequestrum separated. In this process, that is, in the solution of the layer of healthy bone adjoining the dead by means of the purulent matter, and in the attendant formation of granulations, I find enough to account for the demarcation and separation of the sequestrum ; and the absorption which has been assumed to go on at the borders of a portion of necrosed bone I hold to be incompatible with the inflammatory process, while the analogy of the process by which mortified soft parts are cast off renders such a view inadmissible.

The granulations not unfrequently perforate the sequestrum where parts of it are thinner than the rest ; and if this should occur at several spots, the dead bone may be completely covered by them. They have the appearance of being developed from the bone, and they fix it so as to delay its removal. It cannot be admitted, even in this case, that the sequestrum undergoes any absorption, but its perforation may be effected by the solving or corrosive power exerted on its tissue by the matter ; and this further fact may be attributed to the same power that, independently of those irregularities on the sequestrum which arise from the unequal thickness of the bone that has perished, that side of it which faces the suppurating tissue appears rough, worm-eaten, discoloured, and black. There can be little doubt, indeed, that a

sequestrum might be removed in this manner altogether; although at present we are without any observations on the subject made with sufficient care and accuracy to establish it as a fact.

While this process is going on, the dead bone is being replaced by a process of regeneration, which I proceed to describe as it takes place in the different forms of partial necrosis.

In *superficial* necrosis, the inflammation that takes place in the bone around leads to an exudation, which afterwards ossifies upon its surface under the periosteum; and as the inflammation extends more deeply, reaching through the whole thickness of the bone to the inner surface of the medullary canal, and to the spongy diploetic tissue, bone is deposited in those parts also. At the same time, pus and granulations are produced beneath the dead lamella, and the latter form a basis for a new layer of bone. The peripheral exudations first mentioned very frequently grow to considerable dimensions. The earlier the sequestrum is completely removed, so much the sooner does the suppuration cease, and with it the formation of granulations. The latter unite with the cicatrix of the soft parts, and as only a thin layer of them ossifies within the cavity, the scar is generally depressed, and is rendered still more so by the heaping up of exudation upon the healthy bone around.

The muscles remain connected with the old bone for some time after it is dead, reaching it through the openings which are left in the new: but they gradually separate from it, and become implanted in the newly-formed bone (Meckel).

In *internal* necrosis, new osseous matter, generally in considerable quantity, is furnished, chiefly by the outer surface of the bone, and deposited beneath the periosteum, while that membrane becomes closely adherent to the inflamed soft parts around. In the interior of the bone, the separation of the dead piece from the living proceeds in the manner already described, and at length the sequestrum is found inclosed in a shell which consists of a layer of the old bone and a stratum of newly-formed osseous substance, and is lined by granulations. This is the sequestral capsule. If this form of necrosis, occurring in a long bone, should involve only a portion of its shaft, the rest of the medullary canal becomes filled up with new bone:

should it extend the whole length of the shaft, the exudation then occupies the adjoining spongy tissue of the epiphysis.

The sequestral capsule, so long as the sequestrum remains in it, is perforated by openings which vary in number, size, and form, and are named *cloacæ* by Weidmann, and by Troja, *foramina grandia*.

Their usual form is round or oval; in size they equal a pea or a bean; and they lead into the cavity of the sequestral capsule directly, or somewhat obliquely through a short funnel-shaped canal: the inner opening of the cloaca is the narrower, and the outer, which is the wider and the more dependent, runs out, in well-marked cases, into a low rim, the lips of which are rounded off. Besides these, there are sometimes other irregular gaps in the new bone, which may be small or very extensive, and the margins of which are sinuous. Most of these openings communicate with abscesses in the soft parts, which open externally, whilst others are continuous immediately with fistulous canals that lead outwards through the soft parts.

The openings last named are situated at parts where the necrosis, as it extended from within outwards, has advanced to the outermost lamella of the bone, and where consequently no new bone has been deposited; whilst those first described are formed in connection with the suppuration, and they serve for the discharge of the matter, and for the escape of the sequestrum.

All these openings are lined with granulations which secrete pus, and are continuous with the inner membrane of the sequestral capsule.

As soon as the sequestrum is removed from its shell, the granulations rise from the inner surface of the cavity and fill it, and the secretion of matter ceases. This mass then gradually ossifies, and instead of a medullary tube there is produced a solid cylinder of bone. At a later period, a gradual enlargement which takes place in the Haversian canals of the new bone, changes its structure into cellular, and incompletely supplies the place of a medullary tube.

Thus, when the process of regeneration is completed, the bone consists, from without inwards, of the bone exuded beneath the periosteum, of a layer of the old bone, and lastly, of the central mass of bone which has been produced in the gra-

nulations, and which fills up the medullary tube. At first it has a coarse exterior, is misshapen, thick, and uneven, and a marked boundary is clearly distinguishable between its outermost layer and the surface of the old bone: but as the outer layer becomes more dense and homogeneous with the old bone, this boundary line gradually disappears, the whole cylinder gradually loses its misshapen, thick, and coarse look, and acquires the natural form. This, however, is far from being invariably the case, for sometimes at irregular spots adjacent or superjacent to one another, the tissue of the outer new lamella, as well as of the old compact bone, becomes loose and expanded, and its Haversian canals widened: sometimes its actual mass is increased by internal deposition (*hyperostosis interna*), the bone retains its coarse appearance externally, becomes very dense in its texture, and is uncommonly heavy. It frequently happens, that the two states are found together, and the latter appears as if it had been developed from the former. In J. Müller's opinion, the so-called new bone, which is produced after internal necrosis, proceeds for the most part from the old bone, the outer layer of which becomes swollen, and grows uninterruptedly during the continuance of the suppuration by the dilatation of its Haversian canals and the formation of new bone in their interstices. In any case, this increase of bulk or swelling of the old bone is to be distinguished from that expansion and swelling upon which Scarpa grounds his theory of regeneration (Miescher).

The mode in which regeneration takes place, when the whole thickness of a bone is dead, corresponds with what has been already mentioned. An osseous exudation takes place upon the outer surface, as well as in the medullary canal of the healthy bone; and after the sequestrum has been removed, granulations continue to rise from the surfaces of the wound, and new bone is formed in them. The regeneration is in most cases incomplete; the growths from the two ends unite too soon, and the bone is diminished in length, and frequently a false joint is formed.

Necrosis of a whole bone is an extremely rare occurrence.

From what has been said, it appears that the regeneration is accomplished by that part of the old bone which has remained healthy; but there can be no question that the periosteum and other surrounding soft parts, and even newly-formed

vascular tissue, are capable of furnishing an exudation which will become bone. This is clearly proved by the few cases in which spontaneous necrosis of a whole bone has occurred ; by the fact that reproduction ensues in animals when a bone has been entirely removed (Heine) ; by the appearance of bony substance in the middle of openings made in the skull by necrosis, or by injury, as well as by the occurrence of growths of bone in periosteum, and especially in the dura mater.

The foregoing remarks have been directed especially to the long bones, but they apply to necrosis and the process of regeneration in other bones also : only it must be observed, that there is very seldom complete regeneration of any part of a cranial bone lost by necrosis ; and when it does occur, it always takes place very slowly. (p. 153.)

The suppurative process, which ensues upon the death of a bone, may, under various unfavorable local and general conditions, degenerate into an inflammation, attended with an ichorous product, and into caries.

A form of necrosis, differing from that to which the foregoing observations have been especially applicable, is a gangrenous ulceration of spongy bones, corresponding to humid gangrene in the soft parts : it is met with chiefly in hospital gangrene, in bed sloughs, &c. The bone is soft and brittle, is filled with dirty greenish shreds of soft parts in a state of slough, and is saturated with a similar sanious fluid.

5. *Expansion, softening, of the tissue of bone, and the consequent indurations.*—Expansion, or rarefaction, though often combined with softening of bone, must yet be distinguished from it. The former is produced by dilatation of the Haversian canals and cells, and constitutes the disease which is named osteoporosis ; whilst in the latter there is a deficiency of the mineral constituents of the bone, and some disease of its fundamental cartilage.

Osteoporosis consists, then, as has been said, in an enlargement of the Haversian canals and cells of the bone.

a. This state may result from excessive development of the medulla of the bone, or of the tissues which occupy its canals and cells ; while, at the same time, the actual quantity of bony substance remains unaltered. By a rarefaction of its tissue of this kind the bone becomes increased in volume,—

expanded. The walls of the enlarging cavities become thinner and thinner, till at length apertures are formed in the interior of the bone, as well as in its outermost lamella, and the cavities communicate with one another. The expanded bone is soft, coarsely porous, and spongy, and more or less so in proportion to the degree of the disease: it yields to the pressure of the finger, and may be easily cut with a knife: its cavities are filled with a large quantity of darkish-red or reddish-brown medulla, which is traversed by dilated vessels, and contains here and there loose or firm clots of extravasated blood.

Osteoporosis may affect the outer compact portion of a bone, and then, in a cylindrical bone, the dilatation of the longitudinal canals gives it the appearance of being split into filaments; or the disease may be developed in the interior, in the medullary cavity of a long bone. In the latter case, as the rarefaction advances gradually towards the outer layers of the compact wall, the peripheral lamellar system, though preserving its compact state, becomes distended and bulges all round, the cavity exceeds its natural size, and the bone loses its proper form. The bone is swollen out into a rounded, hollow sounding, thin-walled cylinder, which is filled with marrow: at its inner wall are found irregularly dilated longitudinal canals, while nothing remains of the spongy tissue and the network in its interior, but a few delicate lamellæ and threads of bone, which pass across the plug of marrow that fills the canal; so that after maceration, the medullary canal is a mere dilated cavity. Of course, the bone is uncommonly fragile, as it is in the allied disease, excentric atrophy.

Lastly, osteoporosis sometimes affects a bone in its whole thickness; and then the disease may have commenced in its interior, in the medullary cavity or diploetic substance, or at the exterior, or at all of these points at once.

This kind of rarefaction usually affects the whole of a single bone, or single portions of the skeleton, which are intimately associated together, such as the bones of a limb or of the skull; and it affects such bone or bones throughout: more rarely it is partial, *i. e.*, confined to one spot on a bone: the most unusual instance of all is to find it in several bones together. When it is partial it gives rise to the spongy exostosis.

It is most frequently observed in the skull, and advances in that part to a very great degree, the cranial bones in the adult reaching, and sometimes exceeding, a thickness of six or ten lines. It may occur at any period of life, but it is found chiefly either in childhood or old age.

This form of osteoporosis, as has been pointed out, is a consequence of excessive development of the medulla of the bone, and of the soft parts which fill its cavities. No distinct general constitutional disease (dyscrasia), can be assigned as its cause, though it is very important to observe, that osteoporosis, whilst it is one way in which rickets exhibits itself, also frequently recurs in old age, in persons who have other marks of rickets upon them.

β. Osteoporosis sometimes arises from an inflammation of the bone and medulla, which furnishes a product in the cavities of the bone, differing in its nature from the ordinary ossific exudation. (p. 158.) This may be inferred from the traces of recent bony exudation, which are found on bones affected with osteoporosis, and from the fact of the bone beneath soft parts which are in a state of inflammation and ulceration, and that in the neighbourhood of caries, being similarly rarefied. (p. 165.) Moreover, that very painful disease, the *malum coxæ senile*, (which, by the way, occurs in other joints also,) appears to originate in a process of this kind: I hold it to be an inflammatory process of a gouty character, which gives rise to rarefaction, swelling, and a peculiar deformity of the head of the femur and acetabulum,—an osteoporosis succeeded by induration.

These cases of osteoporosis are curable.

γ. A large class of osteoporoses is occasioned by atrophy of the bone. The enlargement of the Haversian canals and the cells, is, in such cases, the result of attenuation of the bony lamellæ which form their walls. There is no increase in the volume of the bone, but rather a diminution; it shrinks and becomes smaller: the enlarged cavities of the bone are filled with a gelatinous or fatty substance, which is mostly of a dirty red, brown, or chocolate colour. The long bones which have a very thick compact wall, are easily fractured; and spongy bones may be broken into by slight pressure with the finger (osteosathyrosis). The bones have lost more or less of their

wright, according to the degree which the disease has reached, and the patients themselves are specifically lighter than water (Saillant).

Senile atrophy of the bones, as it is the most common instance, may serve also as the type of this form of osteoporosis. But it occurs also in youth and manhood, and is then a painful disease, which usually extends over the whole skeleton, and which it is the custom to ascribe to gout, rheumatism, mercurial cachexia, syphiloid disease, and lepra. In the persons we have mentioned, it sometimes proceeds to such an extent, that in spongy bones considerable cavities are formed, which are filled with the diseased marrow above described; and it predisposes to the occurrence of fractures upon the slightest occasions. The part of the skeleton which suffers least in this form of the disease, is the skull. Like mollities ossium, it has proved, up to the present time, incurable.

b. There are two forms in which *softening* of bone presents itself, namely, rhachitis and mollities ossium. Some rarefaction is always present in both, but the essential part of the disease is a return of the bone towards its original cartilaginous structure; while at the same time it may be altered in its chemical composition or not. Hence the bones are not brittle, but soft and flexible; they become curved and misshapen, and are much more easily bent than broken.

a. Rickets (rhachitis juvenilis in contradistinction to rhachitis adultorum and rhachitis senilis, which are equivalent to mollities ossium) is a disease of early childhood. It is, in most cases, developed first in the lower extremities: after having reached a certain degree in them, it extends to the pelvis; and advancing from thence to the other bones of the trunk, it at last pervades the whole skeleton. Sometimes it is more prominently marked in one portion of the skeleton, while the rest of the bones are but slightly affected; and then a rickety thorax or skull constitutes nearly all the disease. It is combined with preternatural development of the glandular system, with hypertrophy of the white substance of the brain, with deficient involution, or even with hypertrophy of the thymus gland, with hypertrophy of the spleen, spare muscular development, and a pale and flabby condition of the muscular fibre. It is associated with tubercle very rarely, considering that the deformity of the thorax which

rickets frequently occasions, brings on conditions suited to the development of that disease.

It interferes with the growth of the bones in length, and with the development of certain portions of the skeleton in their proper relations as to capacity. Some of the deformities which it occasions are produced only in this way, such as shortness of the long bones, and narrowness and small size of the pelvis; whilst sometimes there are other conditions which essentially co-operate in effecting them. Thus the weight of the body pressing perpendicularly on the pelvis and lower extremity gives rise to the sabre-shaped curvatures of the latter, and the flattening anteriorly, the narrowing of the conjugate diameter, and the great inclination of the former; and this is the case whether the deformity be symmetrical on the two sides, or whether it predominate on one side, and the pelvis be oblique or inclined. Lordosis or scoliosis of the vertebral column follows upon the deformity of the pelvis, and the degree of either is proportioned to that in which the vertebrae are affected with rickets. Consequent upon the deviation of the spinal column from its natural direction, ensues corresponding deformity of the thorax. If the muscles of the thorax—the pectorales and serrati—be in a very undeveloped state, a deformity results which is known by the name of the (rickety) pigeon's breast. In the skull, the hypertrophy of the cerebrum, especially of its anterior lobes, moulds the bone into the peculiar corresponding shape. The necessary description of all these changes will be given hereafter; only it must be remarked that, as the deformities which are produced by rickets in the lower extremities and the trunk, depend upon causes that vary much in the degree, the duration, and the manner of their action, so they do not follow constantly any definite type, but rather present, especially in the pelvis, frequent exceptions to any forms which may be set down as the rule.

The bones appear swollen out; the angular shaft of the long bones becomes round and cylindrical; and their articular extremities, as well as other broad bones which contain much diploetic tissue, (such, for instance, as the bones of the pelvis,) become unusually thick.

The texture of the bones is affected in two ways, of which sometimes one preponderates, sometimes the other. In the

first case the bone is rarified and increased in size—expanded in fact. A pale yellowish-red jelly is effused into its enlarged canals and cells, into the medullary cavities, and even under the periosteum. The bone itself is abundantly supplied with vessels and full of blood, and its colour is therefore darker than natural, and red. Occasionally this change reaches such a degree that the cells of spongy bones, and those in the interior of medullary tubes, become excessively distended, and, as their walls disappear, are merged in larger cavities: medullary cavities at last become single spacious chambers, and the bones uncommonly soft and fragile (Guérin's *Consomption Rachitique*). In the *second* case the bone is, in addition, deprived of more or less of its mineral constituents; and sometimes it is completely reduced to its cartilaginous element, and appears like a bone that has been steeped in acid. The bony corpuscles are empty, and their rays have disappeared, and when this is the case, the lamellar structure is here and there obliterated; at other parts the lamellæ appear, as it were, to have fallen asunder, and the corpuscles are seen quite distinctly interposed between them. It is upon this condition that the softness, the flexibility, &c., of rickety bones depends.

These two conditions exist together, as has been remarked, and sometimes one preponderates, sometimes the other: it is, however, remarkable, that in cases of general rickets, the reduction of a bone to its cartilaginous element so preponderates in some bones as to go on, even to completion, without any trace of rarefaction.

The periosteum of rickety bones is palpably more vascular than natural, and tumid; it clings to the bone so closely that a layer of the expanded spongy tissue always comes away in the attempt to strip the membrane off.

Rickets is not a painful disease. It is usually developed in the second year of life, and leaves traces behind it corresponding to the degree it had attained. In small degrees it is capable of cure by the reabsorption of the substance which has been effused into the cavities of the bone, and the subsidence of the swelling of the bone. In more advanced degrees the cure is effected by that substance becoming more and more firm, and at last ossifying. The bone then remains enlarged and becomes uncommonly dense (Guérin's *Eburnéation*), and the

Haversian canals contract, especially on the concave side of the curves. When the disease reaches its highest degree, the rarefaction which it has occasioned and the fragility of the bone are permanent.

β. *Mollities ossium* (*Osteomalacia*, *Malakosteon*, *Rhachitismus adultorum*, and *senilis*), is quite a different disease from true rickets, and affects grown persons in the period between early manhood and old age. It occurs chiefly in the bones of the trunk, to one portion of which it so far confines itself as to proceed to a very great degree in that portion, whilst mere traces of it only are found in other bones. When the bones of the skull and of the extremities are affected, they are so always in a very subordinate degree. It is more frequent in the female sex than in the male; and several times it has been met with coming on after childbed. Not unfrequently it is associated with cancer of the internal organs (a fact which reminds us of the old observation as to the brittleness of the bones in cancer). Sometimes it exists when there is a great production of fat, especially in advanced life; and it is often found when there is also fatty degeneration of the muscles: the import of this last combination is not yet understood, whether it is occasioned by insufficient action of the muscle, or has any essential connection with, and is produced by, the general disease. Compared with rickets, and considering how rarely the disease occurs, its advance to a very considerable degree may be said to be frequent.

The deformities which result from *mollities ossium* are restricted to the trunk, as has been mentioned above. They take place upon the bed to which the patients are confined, and it is this mode of origin that determines the peculiar shape which results from the disease, and which in the pelvis is regarded as characteristic. The two ends of the trunk approach each other by the vertebral column arching backwards; the thorax sinks in, especially at the sides, the ribs becoming curved and bent in various ways; and the pelvis acquires a triangular form, like that of the heart on cards. But these are not the invariable shapes; and the peculiar form of the pelvis is not exclusively a result of *mollities ossium*, but is met with sometimes in bedridden persons, who are the subjects of rickets in a high degree.

The bones diminish in size, and their texture is rarefied and atrophied; they become saturated with fat, and reduced to their cartilaginous element. In this condition their corpuscles are empty, and when viewed by transmitted light, diaphanous: there are no canaliculi (kalkkanälchen), and the lamellar structure is lost. The bone at the same time undergoes a striking change in its chemical composition, the extract produced by boiling being not only different from chondrin, but also from the animal matter of bone.

Upon this last-mentioned character of mollities ossium very probably depends not only an essential difference between it and rickets, but also its malignancy: it is a very painful disease, and hitherto has never been cured.

Consecutive induration appears to me to be the mode in which one of the described processes of expansion and softening of bone subsides or heals. The previous occurrence of such a process is at once sufficient to distinguish it from other indurations, but it is characterised also by peculiarities in the texture, and no doubt also in the chemical composition, of the bone. The anomaly in the texture of the indurated bone is owing to the rarefaction itself, and to the vascularity of the medulla which occupies the enlarged cavities in the bone, and it consists in the arrangement of the elements of the new osseous tissue upon the old bone and around its vessels, in abnormal relative positions. By this anomaly of texture alone, without reference to any change in chemical composition, an explanation is afforded of several varieties in the physical condition of the bone, such as the peculiarity of its fracture, the appearance of its broken surface, and of a thin section, and its colour. Varieties of this kind in a bone, which originate in some peculiarity in the relative position and arrangement of its elementary constituents, have their analogues in inorganic nature, in the different physical condition of bodies which in their chemical composition are alike.

The anomaly in chemical composition may consist in the fundamental cartilage of the indurated bone being overfilled with mineral constituents, the usual proportions of which to each other may be either maintained or altered; or in the presence

of unusual salts; or further, in some abnormal condition of the fundamental cartilage itself, of its blastema, &c.

Bones affected with consecutive induration, retain the increased size which they had acquired during their previous expansion, and are therefore of course augmented in weight by the induration.

a. Well marked specimens of induration may be observed succeeding the expansion which has occurred in advanced life; such cases are most frequent in the skull. A series of skulls of this kind is preserved in the museum at Vienna, and shows, in a most instructive manner, the gradual advance of induration in the expanded cranial bones. Externally, and still more on the cut surface, they present a dull white colour, and a chalky appearance; and their fractured surface is coarse. A minute examination of a transparent slip of such bone exhibits wide, irregular, *i. e.* angular, and sinuous Haversian canals; the lamellar structure deficient, or only here and there perceptible; and bony corpuscles, which are mostly round, lying in disorder one over another, and crossing or obliterating each other.

b. Similar characters are presented in the *malum coxæ senile*, by the indurated head of the femur, and the stalactitic, chalky osteophytes which surround it. It is observed, moreover, that this mass of bone acquires a polish like gypsum. Upon minute examination a close lamellar structure is found; the lamellæ are very numerous, but the bony corpuscles, on the whole, are few, though at some spots they are crowded together in dense groups. The osteophytes present a similar close lamellar structure, and their corpuscles are very numerous and thick, and mostly round and quite black.

c. The induration (*éburnéation*) in which a high degree of rickets terminates, is distinguished by the hardness of the bone, by its glass-like brittleness, and the laminated appearance or leaf-like splitting of its fractured surface. When minutely examined, the Haversian canals are found small, and surrounded by large and widely extending systems of lamellæ, but by few bony corpuscles; those which do exist are small, and, which is remarkable, for the most part transparent, and they have but few canaliculi.

Note.—To this chapter, which contains the greatest quantity,

and the most important part of the matter, I subjoin the results of the analyses of several bones, which Dr. Ragsky had the goodness to undertake at my request.

1. *Osteoporosis of the skull of an old person.*

Specific gravity	0.909	
Cartilage, fat and vessels	38.61	organic constituents.
Basal phosphate of lime and phos- phate of magnesia	55.80	} 61.39 inorganic constituents.
Carbonate of lime, and other salts	5.59	

2. *Slight induration, consequent upon osteoporosis.*

Specific gravity	0.854	
Cartilage, fat and vessels	44.10	organic constituents.
Basal phosphate of lime, with phos- phate of magnesia	48.20	} 55.90 inorganic constituents.
Carbonate of lime	7.45	
Salts soluble in water	0.25	

3. *The same advanced to a higher degree.*

Specific gravity	1.842	
Cartilage, vessels	42.51	organic constituents.
Basal phosphate of lime, with phos- phate of magnesia	50.29	} 57.49 inorganic constituents.
Carbonate of lime and salts	7.20	

4. *The same at its most advanced degree.*

Specific gravity	1.751	
Cartilage, vessels	38.27	organic constituents.
Basal phosphate of lime, with phos- phate of magnesia	55.52	} 61.73 inorganic constituents.
Carbonate of lime	5.95	
Salts soluble in water	0.26	

5. *A tibia indurated, also probably in consequence of osteoporosis.*

Specific gravity	1.490	
Cartilage, vessels	38.49	organic constituents.
Basal phosphate of lime, with phos- phate of magnesia	53.21	} 61.51 inorganic constituents.
Carbonate of lime	8.30	

6. *The gypsum-like coating of the head of a femur affected with so-called "malum coxae senile."*

Specific gravity	0.845	
Cartilage, vessels	33.90	organic constituents.
Basal phosphate of lime, with phos- phate of magnesia	59.10	} 66.10 inorganic constituents.
Carbonate of lime	6.57	
Salts soluble in water	0.43	
Uric acid, which was looked for particularly, was not present.		

7. *A dried scapula, softened by rickets, and a humerus.*

Scapula, specific gravity	0.612	
Cartilage, vessels, fat	81.12	organic constituents.
Basal phosphate of lime, and phos- phate of magnesia	15.60	} 18.88 inorganic constituents.
Carbonate of lime	2.66	
Salts soluble in water	0.62	
The humerus contained 10.54 per cent. of partly fluid, partly crystalline fat.		

8. *Portion of a rib from a skeleton affected with mollities ossium,—the piece was too small for complete investigation.*

Specific gravity	0.721	
Cartilage, fat, vessels	76.20	organic constituents.
Basal phosphate of lime, and phos- phate of magnesia	17.48	} 23.80 inorganic constituents.
Carbonate of lime and other salts . .	6.32	

9. *The rib of a skeleton in which all the bones were attenuated.*

Specific gravity	1.432	
Cartilage and vessels	39.63	organic constituents.
Basal phosphate of lime, and phos- phate of magnesia	51.87	} 60.37 inorganic constituents.
Carbonate of lime and salts soluble in water	8.50	

10. *Syphilitic induration of the skull in a high degree.*

Specific gravity	1.613	
Cartilage, vessels	36.30	organic constituents.
Basal phosphate of lime, and phos- phate of magnesia	57.20	} 63.70 inorganic constituents.
Carbonate of lime	6.50	

11. *Simple benignant induration of the skull of a lunatic.*

Specific gravity	1.911	
Cartilage and vessels	33.41	organic constituents.
Basal phosphate of lime, traces of fluoride of calcium	54.10	} 66.59 inorganic constituents.
Carbonate of lime	10.45	
Phosphate of magnesia	1.00	
Salts soluble in water	1.04	

N.B. Before determining the weight, each bone was sawn into thin slips, dried quickly in an oil-bath, pulverised, and again dried in the oil-bath at 106° Cels.

Tabular view of the properties of the animal matter from the bones examined.

No. of bone.	Mode of formation and character of the Animal Matter.	Effects of reagents on solutions of the Animal Matter.									
		Alcohol.	Acetic acid.	Tincture of galls.	Neutral acetic oxide of lead.	Basal acetic oxide of lead.	Oxy-sulphuret of iron.	Solution of alum.	Chloride of mercury.	Chloride of platinum.	Ferro-cyanuret of potash.
1.	Glue slowly formed. Solution was whitish, turbid, gelatinous.	Thick Precipitate	...	Thick P.	...	...	...	...	Moderate	Thick P.	
2.	Changed slowly into glue. Solution contained much fat, and was white, turbid, and gelatinous.	Thick P.	...	Thick P.	...	...	...	...	P. Soluble P.	Thick P.	
3.	Changed slowly. Solution was whitish, turbid, gelatinous, and contained fat.	Moderate P.	...	Thick P.	...	...	...	...	Moderate P.	Thick P.	
4.	Changed slowly. Solution of a pale yellow colour, rather turbid, had little tendency to become gelatinous.	Turbidity	...	Thick P.	...	...	...	...	Moderate P.	Thick P.	
5.	Changed readily. Solution brownish, turbid, and slightly gelatinous.	Slight P.	...	Thick P.	...	...	...	...	Slight P.	Thick P.	
6.	Changed with much difficulty. Solution brownish-yellow and translucent, had little tendency to become gelatinous.	Moderate P.	...	Thick P.	...	...	...	...	Slight P.	Thick P.	
7.	Changed into glue. Solution brownish, translucent, became slightly gelatinous.	Turbidity	...	Thick P.	...	...	...	...	...	Thick P.	
8.	Changed into glue. Solution was whitish, turbid, and slightly gelatinous.	...	...	Thick P.	...	...	...	...	...	Moderate P.	
9.	Dissolved quickly. Solution was gelatinous, and had a yellowish opacity.	Turbidity	...	Thick P.	...	...	...	...	Moderate P.	Thick P.	
10.	Glue formed slowly. Solution was whitish, opaque and gelatinous.	Slight P.	...	Thick P.	Thick P., which was not dissolved either in acetic acid or by boiling.	...	...	...	Thick P.	Slight P.	
11.	The cartilage changed slowly. Solution was whitish, turbid, and gelatinous.	Considerable turbidity.	...	Thick P.	...	...	...	...	Turbidity	Thick P.	

6. *Adventitious Growths*.—These formations are, on the whole, a rare appearance in the bony system; by far the most frequent of them is cancer. Those which originate in some general diseased condition, are usually the expression of a high degree of it, especially when such diseased condition has the character of dyscrasia: it is, however, a fact of great importance, though it has not yet received much notice, that the dyscrasia, which has established itself in a bone, usually remains fixed there for a long time, and spreads, for the most part, only upon some evident cause, such as forcibly effacing its localized character, that is, extirpating the local affection. With regard to that disease, which old writers named *spina ventosa*, and which has, since their time, been represented in such different forms, I think it best to remark at once, that expansion of bone, from the eventual production of which *spina ventosa* obtained its character as a disease, is a condition common to several of the morbid growths about to be described.

To the actual new formations in bone, I prefix an account of the morbid development of its system of capillary vessels.

a. Teleangiectasis.—It consists in an enlargement of the system of arterial and venous capillary vessels within the bone. It forms rounded soft tumours, which sometimes pulsate, and which attain various, and occasionally very considerable, size. The dilated vessels produce enlargement of the Haversian canals and cells, expansion of the bone, and subsequently by their pressure, absorption of its substance. Generally, also, the vessels become ruptured, and hemorrhages ensue; the extravasated blood forms roomy cavities for itself in the cellular tissue that connects the convoluted vessels, and there coagulates in layers, just as in the sac of an aneurism (Breschet). From special examination of the disease itself, as well as from having met with cancer in other parts of the skeletons in which it occurred, I have been led to believe that it originates in cancer of the bone. In the skull, moreover, I have observed a cavernous structure developed from the diploe.

b. Cysts.—My own experience agrees with published observations of these growths, as to the rarity of their occurrence in bone.

a. The simple cyst, containing a serous or synovial fluid,

may occur in any bone, but it is chiefly met with in those of the face, the lower jaw being the most subject to it, and next the upper jaw. In size it may equal a hen's egg, or even exceed it (Dupuytren). By its pressure it produces atrophy of the osseous tissue, and expands the compact tables of the bone to a thin-walled bladder, which crackles under the finger like a piece of parchment. When this layer is also consumed, the cyst protrudes through and beyond the bone, and its wall becomes strengthened by the periosteum, &c.

β. Compound cystoid growths are very rarely seen in bones. Some cases, however, recorded by old observers, undoubtedly belong to this class; especially one or two of those which Lobstein has collected from his own experience and that of others, and has described under the name of *osteolysis*.

γ. Acephalocysts have been observed in bone eight times. Of these eight cases one, which is preserved in the Vienna Museum, presents considerable interest, from the premises which it affords with regard to the cause of the disease. They have been met with in the humerus, the tibia, the ilium, and the diploe of the skull. In most of the cases recorded by foreign observers, the disease had been developed in consequence of injury. The following is an account of our own case.

The patient, a labourer, aged 42, had, in his youth, suffered from swellings of the cervical and axillary glands; and five years before his death from gonorrhœa and chancre, and consequent bubo. Still later, his penis had been amputated on account of malignant (*bösartig*) ulcerations; and one year before his death the disease, which was afterwards found in his bones, commenced with pains of a tearing and boring character.

When the body was examined, the left ilium was found converted into a fibrous sac as large as a man's fist, which, besides containing numerous splinters of bone, small and large, sticking in the inner wall of the sac, was also filled with echinococcus-bladders (acephalocysts), varying from the size of a millet-seed to that of a nut. Similar sacs, but less in size, were found also in the pubes, ischium, and sacrum, from which bones they projected into the pelvis. Some of the echinococci were free; but others, especially the smaller ones, were situated either singly or in clusters in the dilated pores and cells of the bare

and broken up pieces of the bone. The bottom of the acetabulum was completely destroyed, and the head of the femur projected into an acephalocyst sac, which occupied its place.

c. Abnormal fibrous tissue.—To this class belong :

a. Fibroid tissue, originally deposited as a product of inflammation or exudation, but arrested in its development into bone ; fibroid callus.

β. Fibroid tumours. These occur most in spongy bones, in the articular extremities of long bones, the vertebræ, and the phalanges of the fingers, in the bones of the skull, the lower jaw, and the bones of the pelvis. They sometimes reach a very large size, and distend the bone into a bladder, or so break it up, that it is found scattered in separate fragments through the tumour. The fibroid tumour sometimes has a very dense structure ; at other times it is looser, soft, and elastic, and then merits particular notice, inasmuch as it may be easily mistaken in the living subject for other softer—chiefly cancerous—growths ; especially if it should have attained a large size, and produced inflammation, sloughing, and ulceration of the integuments by the chafing and pressure which it occasions.

d. Enchondroma.—This growth is incomparably more frequent in bone than in any other structure, and presents in the osseous system all those numerous varieties which are incident to it both in its own internal construction, and in the condition of the bone around it.

It is met with chiefly in the bones of the fingers and toes ; it occurs also in the ribs and sternum, and has, moreover, been observed in the bones of the skull, the ilium, and the long bones. Its commencement dates mostly from the period of youth, even though it may have first attracted attention by its enlargement at a later period of life : I have, however, seen cases in which there could be no doubt that it had been developed at an advanced period of life. The variety of aggregated enchondroma I have seen combined with an extensive formation of osteophytes.

Like the permanent cartilages, it generally remains for a long time, and even throughout life, in its original condition : sometimes it ossifies, and I have observed this metamorphosis affecting the last-mentioned variety of the disease in a very

remarkable manner: it has been already described. Lastly, an entire enchondroma is sometimes involved in inflammation of the surrounding soft parts, and destroyed (wird verjaucht).

e. Osteoid.—There can be no question that several of the new growths which occur in bone, though they differ in their nature, may be included under this title. Passing by mere concretions, I may observe, that fibroid growths in bone ossify as well as those in other structures: but, to be more particular, a spherical osseous tumour may be developed by the progressive ossification of a newly-formed cartilaginous basement in an old bone: and it may be distinguished from the normal bony tissue by the difference of its elementary structure. A most remarkable specimen of this kind is preserved in the Vienna Museum. It is the skull of a person of 26 years of age, who died suddenly whilst suffering from Exophthalmos. In the anterior fossa of the base of the skull on the left side there is a tumour, nearly as large as a duck's egg, which appears slightly lobulated on its surface, and is composed of a very dense, dull white, bony structure: a portion of it as large as a walnut projects into the orbit, and forms one process with another portion, of about the size of a hazel-nut, which extends into the zygomatic fossa. This mass of bone springs from the diploe of the frontal bone, forces its compact walls asunder, and perforates them on both sides. There are other tumours near it, similar but smaller in size, which spring from the diploe of the frontal, and greater wing of the sphenoid, bones.

A different osteoid tumour may be developed also from the enchondroma at any period of its existence.

f. Cholesteatoma is rarely seen in bone, and I am aware of but one instance, which is in the Vienna collection. It is that of an encysted cholesteatoma, occupying the mastoid portion of the temporal, and the adjoining occipital bone.

g. Tubercle.—The frequency of tuberculosis in the bony system is unquestioned. The tubercle either assumes the granular form, or, as very frequently occurs, it is a product of inflammation of the bone, and presents the characters of softening tubercle. Tuberculosis affects chiefly cancellous bones, and portions of bones; the bodies of the vertebræ; the spongy articular extremities of the long bones,—especially

the lower end of the femur and upper end of the tibia, and the ends of the bones which compose the elbow-joint; the carpal and tarsal, the metacarpal and metatarsal bones, and the phalanges; and the sternum: more rarely the ribs are attacked, and the cranium; while the parts least frequently affected are the shafts of the long bones.

Its seat is sometimes the outer layer of the bone and the periosteum, and sometimes the deeper bony tissue.

Moreover it very commonly occupies several adjoining bones at once, as for instance, the ends of the bones which form a joint, the whole apparatus of the carpal and tarsal joints, the vertebræ, &c. Young persons are especially subject to it in the years of childhood, and at puberty; but it is also frequent in later, and even in advanced life.

a. Tubercle in the state of gray crude separate granulations can be detected only by close examination of the spongy tissue of a bone in the vicinity of a tubercular abscess. It usually occupies the membrane which lines the Haversian canals and the cells. As the granulations accumulate, they form larger masses of tubercle, and partly compress the bony structure, and partly include necrosed fragments of it amongst them. The aggregate morbid growth is sometimes found as a yellow, lardaceous and cheesy mass; much more frequently it is softened, and consists of a cream-like grayish-yellow pulp, or a thinner, flocculent, tubercular pus. It is contained within a more or less complete lardaceo-callous cyst, which is, in fact, the tissue surrounding the softening tubercle, infiltrated with lardaceo-gelatinous material. If, as is frequently the case, the tuberculous disease should occupy the outer part of a bone and the periosteum, the latter, with the cellular and ligamentous tissues upon it, partakes in the formation of this cyst; and if the tuberculosis advance deeply into the bone, it is mostly the only rudiment of the cyst that can be clearly proved to exist. The best opportunity to observe it, is frequently afforded by the vertebræ.

The degree of congestion which gives rise to primary tubercle, may vary in bone as well as in other tissues; for the development of the disease is, in many cases, unnoticed, while in others it is ushered in with very marked symptoms.

The usual metamorphosis of tubercle in bone is *softening*; but it sometimes also becomes *cretaceous*.

(1.) When it softens, a tubercular ulcer is formed in the bone, which corresponds in extent with the quantity of substance the bone may have lost. The loss of substance arises from necrosis of the portion included in the tubercular mass; and it may die either when first involved in the mass of tubercle, or at a later period: but in either case, it is in consequence of its vessels becoming obstructed, or destroyed in the suppuration.

Softening of tubercle at the surface of a bone, produces a superficial breach of its substance which has the appearance of being unevenly corroded; when a larger and more deeply situated mass softens, the bone is excavated, and a cavern—a tubercular cavern in bone—results. The greater the number of caverns which are found in a macerated bone, or set of bones, the more safely may it be concluded that they originated in the softening of tubercle.

The cavern contains a fluid, which presents the characters of tubercular matter, and is mixed up with numerous particles of bone. Sometimes the particles are small, and resemble crumbled mortar; when larger, they are seen distinctly to be necrosed bone: they are usually of a dirty white colour, soaked through with tubercular matter, and not so brittle as the sequestrum produced by other processes in a spongy bone.

The various processes which are usually found in the neighbourhood of a softening tubercle, occur in bone also.

First, there is a secondary deposition of tubercles, which, as they soften, increase the size of the cavern. The congestion to which the secondary deposition of tubercle is owing, usually advances to the degree of inflammation (reaction), and leads to the formation of a gelatinous granulating product which lines the wall of the cavern, and as the tubercle softens, always breaks down too. Should the tuberculosis have attacked the peripheral layer of a bone, the congestion, vascularity, and product just spoken of, are seen with remarkable distinctness in the periosteum which immediately covers the diseased spot, and may be found also in the adjoining cellular and fibrous tissues. The periosteum is covered and infiltrated with this product, which, gelatinous at first, gradually assumes a lardaceous appearance. The tubercular matter collected under the membrane swells it out like a saccular appendage.

Oftener still, the inflammatory process becomes more intense, and under the influence of a highly advanced state of the general disease, pervades the osseous tissue throughout with a yellow cheesy product, which breaks down at once. Further remarks on this subject will be given below. It occasions a rapid enlargement of the ulcer in the bone, and extensive destruction, not only of the bone in which it originates, but of other tissues into which it may advance.

When the circumstances of the case are more favorable, and the formation of tubercle has ceased, the inflammatory product at the wall of the cavern becomes organized into a fibroid, lardaceo-callous tissue, and that in the bone itself, into bone; and the cavern changes into a thick firm capsule, which becomes surrounded by an indurated (sclerosed) bony tissue. Its contents are then partly reabsorbed, and partly, as the capsule shrivels and diminishes in size, they become inspissated, and form a greasy calcareous pulp, of a grayish-yellow colour, or a mortar which incrusts the walls of the capsule, or a chalky concretion: and thus the tubercular disease is cured.

(2.) Under favorable circumstances, tubercle in bone becomes converted into chalk. A chalky concretion is found in the interior of the bone, inclosed within indurated osseous tissue: if the tubercle have been situated on the surface of the bone, the concretion is covered on the outside by thickened periosteum.

β. A form of tuberculosis, common in young persons, is comprised, in great part, of what are known by the general term of *scrofulous inflammations*.

The inflammation furnishes a tuberculous product by which the actually inflamed spot becomes infiltrated. It may be a primary affection of the bone, or may come on around an abscess already formed from the tubercle above described.

Spongy bones affected with this disease are found at first partly of a dark red colour, injected, and extruding a fatty or gelatinous matter from their cells; and partly pale, and having their cells filled with softening tubercular exudation: both bone and periosteum are frequently swollen, and the former is elastic and soft, and yields easily to pressure or the knife. Ulceration presently begins to destroy it, and the fluid discharged is

either thin, grayish, or yellowish in colour, and mixed with cheesy flakes, and with particles of necrosed bone; or it is coloured of a dirty brown by hemorrhagic exudation, or else is highly discoloured, and blackish green, extremely offensive to the smell, and mixed with black fragments of bone, and with particles of the soft parts destroyed by sloughing.

When this process affects a compact bone, a bone of the skull for instance, its cavities appear filled with tubercular exudation; it becomes of a dirty yellowish-white colour, and is, in fact, necrosed—a tuberculous sequestrum. Similar tubercular product is exuded between the surface of the bone and the periosteum. If the process involve only a superficial layer, the bony tissue is partly lost amid the softening of the tuberculous product, and is partly thrown off in particles which are sufficiently large to be palpable; and thus an uneven rugged surface of bone is exposed, from which the process extends more deeply; the osseous tissue previously becoming indurated, and the bone increasing in volume and thickness.

The abscesses which are produced by the processes just described, advance in various directions from the bone into the soft tissues, which are infiltrated with the gelatinolardaceous matter; after having given rise to other secondary (congestive) abscesses in those tissues, they open externally at a part which is often very far removed from their original seat. This is noticed particularly in abscesses in and about the vertebræ.

After the contents of the abscess have been evacuated, or perhaps have partly cretified, the tuberculous caries heals, leaving an indurated cicatrix in the bone, which deforms it in proportion to the amount of substance it has lost: the cicatrix has a rugged and nodular, streaked, and radiated or knitted appearance, and adheres to the thickened and callous periosteum.

The inflammation of bone which is attended with the production of tubercle, and the caries which thence ensues in the spongy articular portions of the long bones, in the carpal and tarsal bones, and in the phalanges, passed among old writers by the name of *Pædarthrocacia*, while the same affection of the vertebræ is known by the name of "Pott's disease."

h. Sarcoma and cysto-sarcoma occur in bone pretty frequently; they are sometimes situated on its surface, and some-

times developed in its interior. When deeply seated, they usurp the place of the natural bone, and produce atrophy of it by their pressure; or else distend it so that it forms a more or less complete shell. Just as, usually, the tissue of the bone in the neighbourhood of the growth acquires increased density (sclerosis), so, when the morbid growth is superficially seated, a development of new bone takes place, which projects into it in processes like thorns and leaves. And when the morbid growth is of the sarcomatous kind, it is not only encased in an osseous shell, but the bone adjoining the shell enlarges sometimes very considerably, and especially in thickness, while knotted cords of new bone are developed in the tumour, and traverse it in different directions.

i. Cancers. Numerous growths of cancerous nature are met with in bone; they are distinguished from one another by their internal structure and external configuration, as well as by the mode in which they destroy the tissue of the bone.

a. The least frequent is areolar cancer. It forms tumours of greater or less dimensions which protrude from the interior of the bone, and sometimes it exhibits in bone, as in other structures, its remarkable character of developing its peripheral follicles into large bladders or cysts. I have met with a case of this kind in the right superior maxillary bone. In the neighbourhood of the canine fossa, a white and densely honey-combed tissue sprang out of the bone, within the small cells of which a grayish jelly was inclosed: internally it filled the cavity of the antrum Highmorianum, while externally it grew in the form of bladders, which attained such a size, that at length those at the periphery of the growth would have contained a hen's or goose's egg, and the whole mass was as large as a man's head.

β. Fibrous cancer appears sometimes in the form of a nodule, of about the size of a walnut or a hen's egg, which is developed mostly in the medullary canal of the long bones: it displaces the bony tissue, and producing atrophy of it by pressure, is frequently the cause of one or more spontaneous fractures of the bone, which occur upon the most trifling occasion. Sometimes it springs from a broader basis on the surface or in the interior of a bone, becomes a tuberculatd and uneven, lobulated mass, and often reaches a very large

size: it splits the tissue of the bone asunder into filaments and laminae; and new osseous substance, commencing on them at the base of the growth, and developed continuously along the principal fibres in its interior, forms for it a bony skeleton. This kind of cancer is noticed mostly in the bones of the skull and face, and in the long bones.

γ. Medullary cancer appears in the following forms:

(1.) In one, which is a rare form, the bone is infiltrated with a milk-white sap,—a fluid encephaloid mass. A case which was long since described by Saillant, and which has been copied by Lobstein into his chapter on Osteopsathyrosis, ranks, as I believe, in this class: and I am the rather inclined to think so because my own experience furnishes me with a similar case. Its rarity will excuse me for detailing it here, instead of that which Saillant has already published.

A silk weaver, aged 61, had suffered twenty-five years before death from hæmoptysis, and twelve years before from typhus; since then, from repeated attacks of influenza, and as long as he could recollect, from rheumatic pains in his limbs. In the last year of his life he was afflicted with very severe sharp pains in his lower extremities, and transient œdema of the feet. The pains at length extended to the trunk, and affected the thorax more especially. Fever, cough, and dyspnœa came on; diarrhœa supervened; and the patient died in an extreme state of marasmus.

Examination of the body.—It was emaciated in every part, and pallid. The bones of the trunk, especially the ribs, sternum, and vertebræ, were softer than natural: the vertebræ could be easily indented, and contained a whitish, milky, and thin or somewhat thick, and creamy fluid, composed of round elementary cells. It was mostly unmixed, but here and there it was streaked with some dirty-brown medulla. Some of it, in the latter condition, was contained in enlarged cells of the bones of the pelvis, and of the articular extremities of both femora and tibiæ. The inner surface of the whole vault of the skull was lined with a pale red, lardaceo-medullary (cancerous medullary) adventitious growth spread out in a layer of considerable thickness; into one side of it was inwoven a growth from the vitreous table of partly reticular, partly filamentous bone, while on the other side it adhered to the dura mater.

All the lumbar lymphatic glands had coalesced into one whitish, lardaceo-medullary, succulent mass.

Moreover, on the inner surface of the dura mater covering each hemisphere, there was a vascular exudation. In each pleura there were a pound and a half of serum, and that on the right side was mixed with a flocculent exudation. The lower lobe of the right lung was covered with a delicate exudation, and was hepatized in several spots, which were as large as peas or walnuts.

Several of the mesenteric glands were infiltrated with the lardaceo-medullary matter: the mucous membrane of the rectum was injected and of a bluish-red colour, and was covered with islands of exudation as large as linseed. The calyces and pelves of the kidneys were dilated, and contained some very fine yellow urinary sand.

(2.) It usually appears in masses, which very often reach an astonishing size. Sometimes these masses undoubtedly commence as an extensive infiltration, while at other times they consist at first of a morbid growth confined to one small point. In the former case, they forcibly split up the bone into delicate layers, in which regularity of position and of laminar arrangement is less distinct in proportion to the rapidity (tumultuousness) of the growth of the tumour. In the latter case, as the mass makes its way out from the interior of the bone, it distends the compact tables into a bony shell. Sometimes they thus become merely a simple shell; at other times, they are developed into a framework of laminated bony fibres. Moreover, in medullary cancer, a skeleton of divergent laminae often forms upon the filamentous basis of the growth. In other cases, of that part of the bone in which the morbid growth originated, a few small fragments only are found scattered through the mass; or it may have entirely disappeared, and no trace even of fragments may remain.

This form of the disease mostly affects the long bones, from the articular ends of which it is developed; it occurs also in the flat cranial and pelvic bones, and in the sternum and ribs.

(3.) The infiltration with encephaloid juice or sap above described—cancer-cells contained in a fluid blastema—is the lowest degree of consistence which medullary cancer presents; but it occurs in bone in various degrees of consistence from

that of brain to that of a lardaceo-medullary, or of a lardaceo-cartilaginous substance.

The soft loose parenchyma of genuine encephaloid is observed in bone, as in other organs, to be very richly beset with vessels; and they are remarkable for their large size and for the thinness of their walls: the blood escapes from them by repeated hemorrhages; it collects in cells which it forms for itself by thrusting the substance of the growth sometimes far asunder, and in these cells it forms laminated coagula.

Cancer melanodes is found in bone, as well as the white medullary cancer.

(4.) There is a peculiar form of cancer, which Otto describes as a gnawing or erosion of bone: Lobstein speaks of it under the title of Osteolysis; but he includes amongst his cases some which were examples of cystoid disease and cystosarcoma, and perhaps also of areolar cancer. On the broad bones of the skull; or on the ossa innominata, spots are noticed in which a foreign substance occupies the place of the natural bone. Besides other peculiarities, this substance presents very various degrees of consistence, sometimes being lardaceo-cartilaginous, and white or whitish-red; sometimes a fleshy fibred, red substance; sometimes a gelatinous, an albumino-serous, or a fatty and serous fluid, of a yellowish-red or grayish colour, or altogether colourless. It commences in the diploe, which it soon eats away, forming a cavity which, in the bones that have been mentioned, is at first inclosed within their compact tables. This covering disappears at several points, and leaves a smooth round, an oval, or an irregular sinuous opening, or a gap, which is covered on both sides by periosteum. The morbid growth then interweaves itself with this membrane, especially with the dura mater when the skull is affected; and not unfrequently advances in it beyond the margins of the opening in the bone. The diploe is usually eroded to a greater extent than the compact walls of the bone, and hence it is that the margins of the opening are so often uneven and jagged, and the compact tables bevelled from within outwards.

There is generally no elevation of the diseased spot above the level of the bone, or at most it is very slightly raised; yet I have observed, that the growth which fills the cavity in the bone does sometimes rise above the surface, and form a

tumour, which, in a flat bone, projects on both its sides. And especially when the morbid growth consists of a gelatinous fluid, it expands the tables of the bone, in the form of a bladder, and in that state is probably the disease first seen by Van Wy, and named by him Hydrosteon. It must not be confounded with cysts, and cystoid disease of bone.

This form of cancer does not differ in its elementary composition from that of fibrous and medullary cancer: every variety, indicated above, in the aggregation of the elementary parts—in consistence—is sometimes met with in the same individual.

There can be no question as to the cancerous nature of the disease: it is quite common to find it combined with a very extensive production of cancer in the internal organs.

The nidus in which cancer growths originate are the Haversian canals, the tissues lining the cells and medullary cavities of the bones, the medullary system generally; and it is from these points that the compression, the erosion of the bony substance by pressure, and the formation of skeletons in the morbid mass proceed. Cancer almost always originates in the diploe, in cancellous bones and parts of bones, or in the medullary cavities.

The state of the bone in the neighbourhood of the cancer varies in different cases. Sometimes it is affected with hyperostosis,—on its outer surface, widely spread bony exudation, and induration within; sometimes with osteoporosis, atrophy and brittleness; and sometimes it is softened. Under what conditions any of these states exist we are at present ignorant, but it is worthy of remark, that they are not confined to bones immediately adjoining the cancerous disease; for when the mammæ, for instance, are the seat of cancer, not only may the ribs and other bones of the thorax be softened, but distant bones, and even the whole skeleton.

Besides the *primary* cancerous diseases of which we have hitherto been speaking as affecting bone, this system is subject also to *secondary* cancer. Instances of the secondary affection may be observed in the ribs and sternum when the mamma is occupied by cancerous disease, in the skull when a primary growth is situated in the dura mater or brain, and sometimes in the bones of the pelvis, when the same disease affects the uterus. The bone becomes involved, not by mere pressure, though that

may be exerted, but by the advance of the growth into it; the disease is implanted in the tissue of the bone, which degenerates, and suffers a breach of its continuity.

Bone undergoes a peculiar destructive process, when the soft parts covering it are affected with those phagedænic ulcerations which are usually held to be of cancerous nature. They are mostly observed on the bones of the face, and we shall speak of them hereafter, when taking a comparative glance of the diseases of bone.

Cancer of a bone is sometimes the only instance of the disease in the organism; sometimes, and indeed, very often several bones are affected together. It is moreover frequently combined with the same disease in various soft tissues, with cancer in the liver, breast, lung, pleura, uterus, &c. The extirpation of large cancerous growths in bone is usually followed by a very rapid and extensive production of cancer in several internal organs.

It sometimes occurs in early life, but it is generally more frequent in adults.

§ 8. *Foreign bodies in bones.*—In some cases in which mercury has been medicinally employed, either internally or externally, particles of the metal have been found in bone. Fragments of all kinds of instruments by which bones have been wounded, may be left behind in the wound,—as broken points of knives and swords, and bullets which have been shot into a bone. They give rise to tedious inflammation, suppuration, and necrosis, and are often thus loosened and cast out; but sometimes they remain firmly fixed in the bone during the remainder of the life of the individual, surrounded by indurated tissue.

*An attempt to determine the characters of the constitutional affections of Bone, particularly the Inflammations and Caries, by reference especially to the appearance of the Bone after Maceration.**

It appears to me to be a matter of much interest to determine in what manner the processes of inflammation and

* Oesterreichische Med. Jahrbücher, vol. ix, p. 4.

suppuration in bone, which arise from constitutional causes, may be distinguished from one another, and how they may at once be recognised by the characters of the preparation alone: inasmuch as the discovery of certain definite types not only makes us better acquainted with the peculiarities of those processes, but may also assist us in distinguishing them on the living, or, at least, in clearing up doubtful cases of diseased bone when examined on the dead.

The distinctive marks of these processes, so far as they are stamped upon the bone, are comprised in change in its texture at the diseased spot, in some alteration of its shape, in the form and boundary of the ulcer of the bone and the necrosis, in the condition of the neighbouring osseous tissue,—that is, in the different degrees, or total absence of inflammatory reaction, and the quantity and arrangement of its product, &c.,—and in the character of the cicatrix. Moreover, although it has only a secondary bearing on our present subject, yet some attention must be paid to the relation which subsists between different constitutional processes and different bones and parts of bones, to their apparent or palpable tendency to affect compact or spongy, broad and flat, or long bones.

In order to render the subject practical, it is necessary to compare as much as possible corresponding bones. This, however, can be carried out only to a partial extent, inasmuch as several of the processes occur very rarely, or not at all, in particular bones; and it is, therefore, the more important to bring together marked examples of the several diseases referred to.

Syphilis, as is well known, most commonly attacks the flat cranial bones, then the tibia and clavicle, and sometimes the sternum,—in general, therefore, bones which are but thinly covered with soft parts, and compact osseous tissue. It makes its appearance as a painful inflammation, which is more severe at some spots than at others. Where it is most severe, it gives rise to a swelling of the bone (tophus), and to an exudation into its interior, which ossifies and produces a local condensation and permanent thickening of the bone; sometimes, but rarely, exudation takes place on the surface also, which soon hardens in the same manner, and unites with the bone. If the bone be diseased throughout, it swells into

numerous confluent bosses, which correspond to the several seats of more severe inflammation, and it becomes shapeless, thick, coarse, and heavy.

Or after having effected this metamorphosis, it terminates in caries. Ulceration attacks an indurated bone. Sometimes, especially on the cranium, it spreads over a large extent of the outer table of the bone, while at other times it rather commits its ravages deeply, and, in the skull, often perforates the bone.

In the former case, the destruction of the soft parts discloses a large ulcerating surface, covered with a layer of lardaceous jelly, which is softening and becoming purulent, and beneath which the indurated bone appears rough and uneven, and, as it were, gnawed. If the ulcerative process stop, the layer covering the bone becomes organized into a very delicate cicatrix, and the bone recovers, not with a smooth, but with an uneven nodulated surface, which subsequently becomes somewhat eburnated, but never quite loses its rugged character. If the sutures still exist, their sharp indentations become thick and blunted. These changes may be readily detected on the living patient through the integuments and their cicatrix.

A circumscribed ulcer has the circular or sinuous form of syphilitic ulcers, and swollen thick margins, which, in an ulcer that has perforated the cranium, may be rounded off abruptly or bevelled from without inwards.

An ulcer which has occasioned a superficial loss of bone, heals in the same manner as the analogous process in the soft parts; its cicatrix is depressed in the centre, nodulated, and shining. If the bone be destroyed in its whole thickness, the margin of the opening becomes rounded, swelled, and coarse, and here and there somewhat inverted. Perforation from this cause happens in the cranial and nasal bones, and in the palate.

And lastly, if the inflammation end in necrosis, the syphilitic sequestrum, especially if it include the whole thickness of the bone, presents the same characters of induration, thickening, and uneven, gland-like ruggedness of surface.

The most palpable characters of syphilitic bones are the hypertrophy, and especially the density of their tissue, and the absence of deposition of bone upon their surface in any of the known forms of osteophyte. Upon minute examination of a section of a very compact syphilitic skull,

numerous Haversian canals were discovered lying far apart, and separate groups of unusually large and black corpuscles, from which a great number of rays diverged. In a section of a piece of syphilitic skull which appeared porous externally, but was, in fact, very compact, the Haversian canals were found wide, the corpuscles mostly large, and some of them placed at right angles to the canals: in the neighbourhood of particular canals the innermost lamella was transparent, and contained a single row of corpuscles, but it was surrounded by a dark stratum interwoven with very numerous corpuscles, which were thickly set with rays. The lamellar system of some of the larger Haversian canals was uncommonly developed (*mächtig*).

A bone which has been indurated by the syphilitic process is unquestionably liable, at a later period, to expansion of its texture. It seems, however, to happen but rarely; I have observed it once in the tibia, but nowhere else,—never in the cranial bones.

Scrofulous inflammation of bone as it is called, that is inflammation resulting in tubercular product, and scrofulous caries, have been described already (p. 189), with tubercle of bone, and the tuberculous abscess produced by its softening: the chief characters of the macerated bone are all that require notice in this place.

Caries, when it has arisen from inflammation, is surrounded by a superficial deposition of new bone, which in compact structure, like the cranium, assumes the villous form of velvet, and in spongy bones, especially the articular ends of the long bones, becomes a splintered and plated osteophyte. This deposition is the more distinct, as there is no hyperostosis, no induration in the interior of such a bone until the ulceration begins to heal; and then it commences at the base and circumference of the ulceration. But cases of caries frequently run their course without any such production of bone. They are those which occur in persons exhausted by tubercular phthisis of the lungs and intestines; or when caries in the same kind of persons is secondary, when for instance the articular extremities of bones are affected in consequence of inflammation and suppuration of the adjoining synovial membrane; when the ribs and the sternum are eroded by the compression of pulmonary or glandular abscesses; and also

when softened tubercle of the dura mater corrodes and perforates the skull, &c.

Superficial caries, like the analogous ulceration in soft parts, leaves behind it a hardened cicatrix of a round or elongated form, pitted and uneven on its surface, and having a corded appearance as if it had been knit. The bone often continues permanently diminished in size.

Tubercle, when it softens in spongy bones, as in the bodies of the vertebrae, destroys the bone in rounded spots, which are clustered together so as to give it a honeycombed appearance.

The destruction to which the bones of the face and cranium are subject from so-called facial cancer, is altogether different from both these processes. Equally unlike them and every other destructive process, it is distinguished by mere negative marks, and may be recognised at the first glance. The surface of the bone and its diploe are successively destroyed by a kind of dissolution or corrosion: nothing is seen in any part but normal bony tissue laid bare; nowhere is there any obvious trace of expansion of the bone, of induration, or of new bony tissue (osteophyte).

The solution, in cases of noma (*Wasserkrebs*, *cancrum oris*), affects principally the animal part of the bone, and is very similar to that just described; the bone looks as if it had been calcined. (*Froriep.*)

But the most difficult point to determine is the changes which are produced in the structure of bone by genuine arthritis. For there are so many anomalies in those affections of the bones which, on the living subject, are attributed to uncomplicated gout, that one is compelled to doubt whether they are all connected with one and the same process. Adventitious growths of various kinds and metamorphoses of apparently syphilitic nature are ranged together under this head with primary indurations, osteoporoses, with consecutive indurations, atrophy, mollities ossium, with different osteophytes, ivory exostosis, &c.

The following changes may, I believe, be looked upon as arising from gout.

There is a metamorphosis in the bony structure of joints, especially in those of the hip-joint, which I agree with some older observers (*Portal*, *Koehler*, *Austin*) in attributing to an arthritic inflammatory process. It is the same as that which

the English denominate 'malum coxæ senile.' It presents the following characters :

a. The cavities of joints (acetabula) become enlarged, and mostly flattened.

β. The head, or convex part within the joint, acquires a flattened surface, and an overhanging margin : in the instances of the head of the femur, of the humerus, of the radius, &c., it assumes the form of a mushroom.

γ. The cartilage which covers the bone is removed, and the cancellous tissue to a varying depth underneath it converted into a dense, white, chalky mass, which is polished like marble on its articular surface by constant friction.

δ. An exuberant growth of bone takes place around the joint, in the form of a cup-like and warty stalactitic osteophyte ; similar masses accumulate outside the joint, which all consist of the same white, chalky substance as the overhanging margin of the head of the bone.

The process by which this change is produced, is a painful one, consisting, without doubt, in an inflammatory rarefaction, swelling and softening of the bone. After furnishing an osseous exudation within the tissue of the bone and all around,—an exudation, which may be distinguished by its form and chemical composition,—it terminates in consecutive induration.

It occurs most frequently in the hip-joint, but it is also observed in the shoulder, elbow, and knee, and in the joints of the fingers, and odontoid process. The whole joint becomes misshapen with the excrescences projecting around it.

The disease in the bone is, moreover, sometimes accompanied by similar osseous depositions in the fibrous capsule of the joint, and in neighbouring fibrous structures ; they assume various forms, like cups or thorns, or are rounded and bossy.

That inflammation seems to me to belong to the same class, which affects long bones, and besides producing induration of their substance, gives rise to a warty and stalactitic osteophyte upon their surface, which renders them rough, like the bark of a tree. And this may be the case also with the osteophyte that grows in cup-shaped, plate-like, thorny, or gnarled, processes, in the substance of ligamentous structures near joints, or on the bodies of the vertebræ. They are very often composed of an indurated chalky substance.

Lastly, under circumstances at present unknown, but especially in aged persons, gout produces a painful atrophy, and concomitant brittleness of the bones, rendering them liable to fracture.

Whether rheumatism gives rise to an inflammation that can be distinguished by any definite characters of its products, or to any peculiar caries, is not yet ascertained, however positively assertions be made on the point. There is, probably, no such thing as rheumatic caries. The abscesses upon and within bone, which have been given out as such, I have always recognised as tubercular. Rheumatic inflammation appears generally to attack the periosteum and outermost laminae of the bone, and to produce induration of its tissue, and a warty plated osteophyte on its surface. It is evidently a change closely allied to that which arises from gouty inflammation.

Appendix.—Anomalies and Diseases of the Medulla.

Although it is highly probable that the medulla is the part in which all pathological plastic processes in bone originate, yet very little is known of its diseases. And upon this deficiency of information it no doubt depends, that, on the one hand, our opportunities of investigating the diseases of the medulla are almost entirely confined to very advanced cases,—cases in which the whole bone is involved in the disease,—and hence that, on the other hand, whilst studying the changes in the actual bony tissue, we are in the habit of paying less attention to the medulla.

Oftentimes, in consequence of *hypertrophy*, it is augmented in quantity, and its increase occasions dilatation of the Haversian canals, the cancelli, and the medullary cavities, in which it is contained. Such hypertrophy is unquestionably the cause, either by itself or in combination with other processes, of many of the osteoporoses, both those which are circumscribed, and those which extend throughout a bone. While increased in its quantity, it may retain or depart from its normal texture and composition. Thus instead of the jelly which fills the cells of the spongy tissue of some portions of bones, of the diploe of the bones of the skull, for instance, actual medulla is

sometimes found, even in the form of compact lobular masses.

Its excessive accumulation leads at length to atrophy of the spongy and reticular bony substance, and to expansion of the compact walls of the bone.

On the other hand, when the bone is affected with concentric *atrophy*, the medulla shrinks as well as the bony tissue, otherwise its place is taken by a gelatinous, fatty, or serous fluid.

In colour and consistence it very frequently deviates from its usual condition, and so also in its texture and composition. The former changes are usually mainly dependent upon the latter in relation to their cause.

The *colour* is sometimes unusually pale or white, sometimes it is a dark yellow; and it frequently acquires various hues of red, rusty brown, yeast yellow, or chocolate, from mixture with blood: it is variously discoloured when caries is going on in the bone.

In *consistence* it is sometimes too thin, being liquefied by serum, or oleaginous; in other cases it is unusually firm, it resembles suet or adipocere, and may be broken.

In reference to its *texture*, it is liable to congestion, and to hemorrhage, by which it may be discoloured, and assume a dark red, chocolate, rusty brown, or yeast yellow hue.

The real seat of *inflammation* in bone is the membrane which lines its cavities. The inflammation of this membrane leads to an exudation which sometimes becomes organized into bone, and sometimes is converted into cellular or fibroid tissue, as may be seen after injuries of bone, or, more rarely, in consequence of spontaneous inflammatory processes; *i. e.*, the medullary membrane and its prolongations undergo fibroid thickening: lastly, the products of the inflammation are sometimes purulent or ichorous, and in various ways destroy the structure in which they are deposited, and the bony tissue. The anatomical marks of these processes are self-evident; they may be recognised also by reference to what has been said about inflammation of bone and its consequences.

In dropsy, the place of the fat in the medulla is gradually taken by a thin, gelatinous, and finally serous fluid.

There are some remarkable changes already alluded to, which the marrow undergoes in osteoporosis and mollities ossium, but their exact nature is still unknown.

Finally, the medullary membrane is the structure in which all *adventitious growths* in bone originate. Tubercle and cancer afford easy proofs of this remark, especially many forms of the latter, such as encephaloid infiltration of bone, and the cancerous diseases named *erosion* by Otto, and *osteolysis* by Lobstein.

CHAPTER II.

ANOMALIES AND DISEASES OF PARTICULAR PARTS OF THE SKELETON, AND OF THE SEVERAL BONES COMPOSING THEM.

SECTION I.—THE SKULL AND ITS SEVERAL PARTS.

§ 1. *Deficiency and Excess of Development.*—In cases of Acephalus, the skull is altogether wanting, or is reduced to a merely rudimentary condition. It is liable, also, to various degrees of defect, in Acrania being without any vault, and in Encephalocele and Anencephalus presenting various, but less, degrees of the same anomaly. Defects of other parts of it are noticed when the cranial or facial bones are fissured, when certain portions of the brain are wanting, or symmetrical parts of it are fused together, as happens in Cyclopia, &c. Examples are also met with in which the development of the skull is arrested in a less degree, apertures closed by membrane being found in its bones, or large membranous interspaces between those that form the cranial vault: the fontanelles are large, or unusual ones exist; or certain sutures continue permanently unclosed. The cases of this class mostly owe their origin to a preternaturally large size of the brain—to Hypertrophy or Hydrocephalus.

The number of bones composing the skull is occasionally incomplete; particular bones are wanting altogether, and sometimes their place is supplied by the enlargement of those in the neighbourhood; thus the nasal processes of the superior maxillaries may occupy the space which is left by deficiency of the nasal or lachrymal bones.

An excess of development is observed in those cases where more or less of a second head is formed; and premature closure

of the sutures and fontanelles constitutes another, but a less, degree of the same general condition.

When certain sutures, such as the frontal, do not close, when there are unusual accessory sutures, such, for instance, as a horizontal one through the parietal bones, but especially when Wormian bones exist, the number of the bones of the skull is increased.

The Wormian bones are most common in the lambdoidal suture, and in the squamous; they are less frequent in the coronal and sagittal, and are most rare where the wings of the sphenoid meet the parietal and temporal bones, and the roofs of the orbits. In the lambdoidal and squamous sutures they are not unfrequently very numerous, and even form two or three rows and as many sutures. When they occur in the other sutures they are often only single: and this is true especially of the sutures surrounding the wings of the sphenoid bone. In their situation, as well as in their dimensions and form, they are usually symmetrical, though there are some interesting cases in which those of the one side do not correspond with those on the other. A Wormian bone situated over a fontanelle receives the special denomination of a fontanellar bone. Finally, the outer layer of the Wormian bones is usually broader than the inner: sometimes they form part of the outer table of the skull only, and, in rare instances, only of the inner. Their existence is chiefly to be accounted for by the large interspaces which are left between the cranial bones in congenital hypertrophy of the brain and in hydrocephalus.

§ 2. *Anomalies in the Size of the Skull.*—The skull, like the brain, may deviate in either direction from its proper size. In some cases it does not reach, in others it exceeds its natural dimensions. Smallness of size may be general over the whole skull, or may be confined to some particular portion of it. Except when it is occasioned by protrusions of the brain beyond the bounds of the skull (encephalocele), it necessarily involves that the brain generally be small, or that some portion of it be deficient or undeveloped; and in the latter case, the corresponding part of the skull is also wanting or but partially developed. The skull may be only relatively small, or it may be absolutely so: in the latter case the smallness of size occa-

sions idiocy, and is a congenital state; a partial diminution is sometimes acquired subsequently to birth, particular parts of the skull becoming small and flattened, sinking in, and shrinking, when the corresponding portions of the brain are in a state of atrophy.

The bones of the face are of small size in cases of congenital hydrocephalus, and their smallness is more striking in proportion to the enlargement of the cranium. A diminution in the size of the bones of the face is also observed in old age: it is chiefly due to wasting of the maxillary apparatus. And a similar attenuation is observed on one side of the face as a consequence of paralysis or neuralgia.

Increase in the size of the skull, when congenital, involves an excessive development of the brain, or, what is more frequent, hydrocephalus. The enlargement is mostly uniform and symmetrical, but in some exceptional cases the skull bulges in one direction or another, a particular section of it is more capacious than the rest, &c.

The dimensions of the skull rarely enlarge at any period after birth—that is, in the sense of increase of its capacity—without some appearance of absorption of the vitreous table, or separation of the sutures; still more rarely does it occur at mature age when the bones are completely formed, and almost never when the sutures are closed. It is seen occasionally at certain parts of the skull.

The bones of the skull and face are subject to many considerable variations in their thickness, sometimes being enlarged (hyperostosis), and sometimes attenuated. Hypertrophy usually commences with the bones of the cranium, it occurs in them frequently, and advances to a very considerable extent; whilst atrophy, especially that form which is peculiar to old age, is more common in the facial bones.

Hyperostosis almost always presents itself in both its forms, namely, that of deposition externally upon the bone, and simultaneous condensation of its tissue (sclerosis): in a few cases it goes on to such an extent, that the skull is not only, according to Jadelod and Ilg, larger than natural, misshapen, and uncommonly thick (9 lines to $1\frac{1}{2}$ or 2 inches), but it also acquires a weight that is almost incredible. In the later periods of the disease, if not at its commencement, the thickening takes place

at the expense of the cranial and adjoining cavities,—orbits, nares, labyrinths, and antra Highmoriana,—as well as of the foramina and fissures which are traversed by the nerves and vessels: the sutures also disappear. Other bones, and even the whole skeleton, may be increased in bulk, when the skull is thus affected; but the disease may be entirely confined to the skull, or even to the cranial bones alone, and those of the face, of other parts of the body, and the base of the cranium itself may remain of their natural size. Not unfrequently, indeed, this hyperostosis of the cranium is associated with atrophy of the bones of the face and of the rest of the skeleton. In any case, it reaches its greatest extent in the cranial vault, and at its frontal and occipital portions: when it occurs in the bones of the face, it is most developed in the lower and upper maxillary bones. It may occur in early youth, in adult, or in advanced life,—a circumstance which depends partly upon the nature of the process.

α. It is sometimes the consequence of an overgrowth or excessive nutrition of the bone, the conditions of which are as yet unknown to us. It is generally developed slowly. It occurs chiefly in adult life; and frequently is associated with ivory-like exostosis on the outer table of the skull, with enlargement and prominence of the inner table, especially near the frontal ridge, and with a growth of bone upon the dura mater.

β. At other times it arises from an inflammation of the bone, which may be acute and recur from time to time, or may be chronic and continued. The pericranium on the one side, and the dura mater on the other, take part in the inflammatory process.

The first of these forms furnishes an exudation of bone upon the surface of the cranial bones, which varies in thickness, and presents the characters of the velvety, finely filamentous, and reticulated osteophyte: it gradually becomes identified with the bone, either with or without the intervention of a newly formed layer of diploe.

Processes of this kind mostly take place on the inner table of the skull, and especially upon and near those spots which are best supplied with vessels; they are, therefore, common along the sinuses and the sutural margins of the bones, and furnish the bone at those parts with a new vitreous table.

Moreover, they are processes which occur chiefly in young persons. The exudation of bone, which is met with on the inner table of the skull in pregnant women, deserves an especial notice. It is so frequently observed in women under such circumstances, and advances in them to so great an extent, compared with what it reaches in other cases, that some connection between it and pregnancy must be admitted; and as it has been regarded with interest, since the time of its discovery in this Institution,¹ I devote the following paragraphs to an account of it.

The *puerperal osteophyte*, as it is usually termed amongst us, because we commonly observe it in persons who have died in consequence of the puerperal state, generally occupies the frontal and parietal bones: sometimes it is found covering the whole inner surface of the cranial vault, and in that case it may be noticed scattered in patches over the base of the skull also. But it does not usually occupy large extents of surface completely, even when it is of considerable thickness, the eminences on the inner surface of the skull, and more rarely the depressions, being left uncovered. Such bare spots on the vitreous table, whether they be situated on the eminences or depressions, are parts at which their own pressure, or that of the brain, has prevented the deposition of the exudation, and they are at once distinguished by having lost their polish and natural colour.

The layer of new bone varies in thickness, from that of a very thin film to half a line, a line, or more. It is usually thickest along the sutures, the longitudinal furrow, and the grooves for the *arteria meningeal media*; it always becomes thinner towards its margins, and is lost in a delicate film.

Its colour presents various shades and modifications of red; it almost always becomes paler towards its margin, and at that part is reddish white, white with red beneath, shining through it, or quite white. This depends on the age of the exudation, on the progress which it has made in its change into cartilage and bone, and on the development of a diploetic tissue within it.

It exhibits in its texture the same stages of development as any other ossific exudation.

¹ Oestr. Med. Jahrbüch., vol. xv, p. 4.

(1.) It is at first a whitish red or yellowish red, gelatinous exudation, which is becoming vascular; it can be easily removed from the bone, and the vitreous table beneath is found to be natural, or to have merely lost some of its polished appearance.

(2.) It is a soft, flexible, cartilaginous lamina, full of minute pores; the vitreous table beneath is generally distinctly rough, or at any rate has its pores manifestly enlarged.

(3.) At the commencement of this stage it forms a flexible lamina, which is smooth and very finely porous, where it is opposed to the dura mater, while on the side which joins the vitreous table it is rough, cellular, and partly cartilaginous, partly osseous. A sanguineo-serous fluid oozes, under pressure, out of its numberless minute pores; and the cellular spaces on the opposite side are filled with a yellowish red jelly, and sometimes with a clear red bloody fluid. It is firmly adherent, and is seen, when an attempt is made to remove it, to be united to the vitreous table by the numerous lamellæ and meshes of the cancellous, succulent tissue before mentioned; both these and numerous vessels are torn in separating the osteophyte.

The new growth is not developed beyond this point during pregnancy, or during any morbid puerperal condition which may succeed parturition; but at a later period it ossifies completely, and forms an integral part of the wall of the skull; it becomes, in fact, a new vitreous table, in some instances being dense (sclerosed) all through, in others united to the old vitreous table by an intervening cancellous layer. Generally, when the calvarium is removed, the new growth clings to the inner surface of the skull; but sometimes it separates from the skull, and remains adherent to the dura mater.

When the exudation is more than usually thick and extensive, a similar, but thinner, stratum is found on the outer table of the skull: at this part, also, as on the inner table, it appears to select the frontal and parietal bones, and is deposited chiefly along the coronal and sagittal sutures, and along the part at which the temporal muscle is attached, and the linea semicircularis; it may even be found on the external surface of several of the bones of the face, especially on the superior maxillary and nasal.

That there is no connection whatever between this new

growth and the puerperal diseases of which the patients died, will be perceived from the following observations.

It presents itself in all its varieties of extent, thickness, and internal development, in the most rapid instances of puerperal disease: it is met with in cases of speedy death from rupture of the uterus during parturition, and when hemorrhages from that organ, during or after labour, have quickly exhausted the patient, as well as when Asiatic cholera, in its swiftest course, has carried off a woman during her pregnancy. The fact is more clearly proved from these growths being found in persons who, either during their confinement, or soon after it, have died of a disease quite independent of the generative organs, and one which may have arisen a long or a short time before the end of pregnancy, or even during labour, such, for instance, as pneumonia, phthisis, cholera, or apoplexy. Again there are other cases still more convincing, in which the growth is found in healthy pregnant persons, who have met with unexpected and sudden death at an advanced period of pregnancy. But the fullest conviction is afforded by the discovery of this growth in females, who, at any period of their pregnancy, back to the third month, have died in a rapid or sudden manner.

The osseous growth under consideration, therefore, in pregnant and parturient women, is a phenomenon which, under circumstances hitherto unknown, is attendant on, and originates from, the pregnant condition.

The question as to the period of pregnancy at which the growth commences, is answered by the fact of its having been met with in every month as far back as the third: on one occasion, in which pregnancy was over, and the woman had been confined, it was but little developed, and existed only at a few small spots; on other occasions, at early periods of pregnancy, it extended over large tracts of the skull, its thickness was considerable, and its texture well developed. Its commencement, therefore, cannot be fixed at any definite period of pregnancy.

The exudation when completely ossified, and united with the old vitreous table, increases the mass of the skull in a degree commensurate with its own thickness; and this, of course, is very evident in cases of repeated pregnancy, in which several

exudations have been deposited. And a highly instructive fact may be noticed in cases of this class, that some one of the more recent laminae of bone does not lie in immediate contact with the older layer, but is connected with it by an intervening stratum of diploetic tissue. In those cases in which the dura mater shares in the process, that portion of exudation which it supplies becomes a vascular cellular tissue, and is either spread out as such uniformly, or collected in patches here and there; and the new osseous lamina, being both perforated by the numerous vessels of the cellular tissue and grooved by them as they wind along its surface, does not possess so smooth and polished a surface as the original vitreous table; the dura mater and the skull, therefore, are more intimately connected, and adhere to each other more closely than natural. This connection is most firm, as might be gathered from my earlier remarks, along the sutures and sinuses, and especially near the longitudinal sinus.

What has been said establishes the existence of a puerperal hyperostosis of the skull, and its connection with repeated pregnancies.

In contrast with the frequency with which this growth is found in the bodies of women who either are pregnant or have been recently confined, it is quite rare in other persons, especially in men, to meet with a new formation of bone resembling it in situation, extent, or form. I can recall altogether but eighteen such cases, and the persons in whom it occurred were most of them young, and had died of very various diseases. Exudations indeed are deposited on the vitreous table in both sexes and at all ages; but they are less extensive than the puerperal osteophyte, and are usually confined to the neighbourhood of the longitudinal furrow. And very frequently, and even commonly, they are already transformed into a layer of bone, are porous, and covered with serpentine furrows, and have adherent to them a growth of organized cellular tissue, which springs from the dura mater.

The remaining exudations of bone which take place upon the inner surface of the skull resemble needles, splinters, and plates; or they appear as if they had been dropped or poured upon the bone in a fluid state, and had then coagulated.

Chronic inflammation gives rise to a considerable thickening

and induration of the walls of the skull, and irregularity and roughness of their surface, with, sometimes, an almost monstrous thickening and fibro-lardaceous condensation of the pericranium on the one side and the dura mater on the other.

This class of disease includes also the hyperostosis of the cranial bones, which originates in their infection with syphilis.

γ. Lastly, the increase of volume, or hyperostosis, may be the induration consecutive upon a rickety state of the bones of the skull, or upon the expansion of bone which resembles that of rickets, but commences at later periods of life. The latter cases are distinguished by the chalky appearance and dull white colour of the substance of the cranial bones, and by the coarse grain of their fracture: their surfaces are rough, and the inner table especially exhibits permanently enlarged pores and deep impressions for vessels.

The most extreme cases of hyperostosis are those of chronic inflammation, and the last-mentioned consecutive induration. All the rare instances of enormous thickening and induration of the cranial bones appear to be of that nature.

The principal example of partial hyperostosis is the ivory-like exostosis which is frequently observed on the skull. It is almost always combined with considerable induration of the cranial bones. On the inner table, in the neighbourhood of the frontal suture, there frequently exist smooth, or rough and striated elevations, which are produced by local expansion and subsequent induration of the skull. Finally, plates or rounded masses of bone, mostly of small size, are sometimes found glued on, as it were, in rugged depressions, on the inner table: they were originally productions from the dura mater.

By far the greatest number of cases of *atrophy* of the skull are those which are peculiar to old age. The bones chiefly affected are the facial, and of these most commonly the maxillary bones. It is an atrophy associated with wasting of the whole skeleton.

A remarkable attenuation of the wall of the skull occurs symmetrically at the top of the parietal bones in old and decrepit persons. At an oval or elliptical spot, the diploe shrinks to such an extent, that the two compact tables unite with one another, and constitute a translucent layer not thicker than a sheet of

paper. The diploe around accumulates, so that the bone is thickened externally by an uneven swelling. No internal cause for the appearance has as yet been discovered, though it appears to me not improbable, that it has some connection with inveterate syphilis.

Atrophy is, in some instances, confined to certain portions of the skull; it then presents itself either in the form of diminution of particular parts of the cavity of the skull, or of other cells and cavities in the cranial and facial bones; or it arises, as has been already remarked, from palsy, neuralgia, exhausting reparative processes after injuries, caries, &c.

Absorption of bone (*Usura*, *Detritus*) occurs very frequently, and reaches a very advanced degree, in the bones of the skull. In the cranium, when confined to circumscribed spots, it is mostly induced by cancerous growths, such as fungus of the dura mater, or by morbid enlargement of the pituitary gland; when it extends over the whole inner surface of the skull, it arises from hypertrophy, or some displacement of the brain.

§ 3. *Deviations of Form.*—The skull is subject to very various deviations from its healthy form. It will be sufficient to furnish a general account of them, without entering into a detailed description of any but the most important.

Very considerable malformations, both of the cranial and facial portions of the skull, form an essential part of the conditions already described as hemicephalus, encephalocele, and hydrencephalocele, of congenital hydrocephalus, fissures of the facial bones, cycloopia, &c. In that rare form of encephalocele, in which the protrusion takes place through the ethmoid bone, the vault of the skull sinks down upon its base in the form of a saddle.

In congenital hypertrophy of the brain, but especially in congenital hydrocephalus, the size of the cranium is strikingly disproportioned to the small dimensions of the facial skull. The cranium may be expanded to a circumference of two feet or more; the frontal and parietal bones, especially, being very large, as well as the membranes filling the interspaces between them: the forehead projects greatly, the orbital plates are forced downwards, and so compress the orbits that they become

mere narrow transverse fissures: the squamous portions of the temporal bones, and the broad plates of the occipital, incline towards a horizontal direction, the external meatus of the ears are depressed, and the base of the skull, besides being depressed, is remarkably small in proportion to the cavity of the skull. If, despite the large size of the skull, its ossification should be completed, the margins of the bones reach each other by means of long, ray-like denticulations, or they just meet along a sinuous suture (*Harmonia*), or else *ossa triquetra* are developed in the interspaces between them. One of the parietal bones, or one half of the frontal, may be increased in size, whilst the other remains unaltered, and then the sutures follow an unusual direction. This is the ordinary form in chronic congenital hydrocephalus; but if, during some interruption of the disease, certain sutures should have closed, a recurrence of the hydrocephalus will produce material alterations in it; the distension will take an unusual direction, and the head deviate, accordingly, from the ordinary hydrocephalic form.

Deficiency in the development of certain parts of the brain produces important deformities of the skull; such as flattening, or receding of the forehead, flattening of the back of the head, &c. The deformity is very striking, when it occurs only on one side. The most frequent deformities are those in which there is a preponderance of some one diameter, so that the skull is longer, broader, higher, or, in some other direction, greater than natural. Allied to these are the round, the blunt four-cornered, and similar skulls, and those which are oblique. At one time the obliquity is found to consist in a displacement of the halves of the skull in a longitudinal or a vertical direction: and in this way the law of compensation is carried out, the apparently greater width of the cranial cavity on one side being made up for by its condition on the other. When the obliquity is considerable, the facial skull shares in it. At another time, the obliquity is occasioned by a lateral displacement of the several cranial vertebræ (which Carus names *Scoliosis* of the skull), so that the mesial line of the base of the skull is curved or serpentine. Other obliquities arise from atrophy of the bones on one side; they are most marked in the face.

Malformations of a peculiar kind, are produced by great projection of the cerebral skull above and in front of the facial; or, as is more frequently the case, by its receding behind the face; the facial angle is consequently either too great or too small.

The base of the skull is sometimes pressed in, in a remarkable manner, by the cervical vertebræ. The skulls in which I have observed this deformity were large, and were those of persons who had suffered, very probably during foetal life, from a moderate degree of chronic hydrocephalus. The portion which encroached upon the cavity of the skull was, in all cases, very thin. The special conditions under which this malformation occurs are unknown.

Lastly, the skull becomes misshapen in various ways, from fracture, indentation, depression, &c.

The shape of the cavity generally corresponds with the external form of the skull, though it may be altered without any deviation from the natural appearance of the exterior. The inner table is sometimes, as in rickets, unusually smooth and polished; and, sometimes, the elevations and depressions are unusually marked. The elevations, and some prominences, such as the clinoid processes, or the eminentia inuominata, are occasionally developed into thorn-like, pointed processes, sharp ledges, or shapeless swellings. Sometimes, thorns of this kind are found at unusual places, such as the sella turcica, or on its pommel, on the basilar process, &c.

When deformities of this class occur in cases of hydrocephalus and hypertrophy of the brain, and especially when, at the same time, the subject of them is rickety, the condition of the sutures is peculiar. In a few cases the denticulations form long radiating processes, but generally they are wanting, and the sutures are a mere sinuous apposition of the bones. In hyperostosis of the skull, especially in cases of syphilitic induration, the sutures become changed into a similar 'harmonia.'

§ 4. *Anomalies in the mutual connection of the Cranial Bones.*—The connection between the bones of the skull may be loosened, and their sutures separated (diastasis). This separation very rarely occurs, and is less important as a result of

violent injury to the skull from falls, blows, &c., than when it takes place in consequence of a rapid advance and extreme degree of hypertrophy of the brain, or of hydrocephalus.

The opposite anomaly is that of a premature closure of some, or all, of the sutures. From the thinness of the cartilage the sutures generally unite first at the inner surface of the skull.

Of the bones of the face, the lower jaw may be dislocated, or its joint ankylosed.

§ 5. *Solutions of Continuity.*—The skull is very liable to solutions of continuity, in consequence of its exposure to mechanical injuries. In the infant it may be indented and fissured, or simply indented by the pelvis of the mother, or by the misapplication of instruments to facilitate the birth of the child. Various kinds of punctured and shot wounds, fracture and crushing of the skull, may take place at the spot to which violence has been directly applied; and at the same time bone may be depressed or fragments driven in (*impressio et depressio*); the tables may be separated and splintered; there may be fissure and *contrafissure*; the bones may be denuded of their covering of soft parts, or there may be simply concussion of the bone within a circumscribed space. Lastly, the openings made in the skull artificially with the trepan belong to the same class.

All these injuries are of a grave character, not only on account of the violence done to the brain and its membranes by the penetrating instrument or by depressed fragments of bone; but also, independently of such complication, from the concussion which the brain and its membranes frequently suffer at the time of the injury, as well as on account of the extravasation of blood which takes place immediately beneath the bone, or *dura mater*, or into the *pia mater*, or the brain. They may be rendered further serious, irrespectively of the foregoing causes, by the supervention of inflammation of the bone and *dura mater*, which is usually so much aggravated by the contusion and concussion that have generally happened as to go on to the production of pus and sanies, and readily pass from the external parts to the inner membranes of the brain.

Nevertheless, punctured wounds, fractures, and considerable

injuries to the walls of the skull, even when combined with displacement of the fragments, do often heal by first intention, or by the way of suppuration. Fractured surfaces become soldered to each other by bony callus; or, after being rounded off by absorption or exfoliation, they are held together by means of a fibroid callus; and the fragments which perish, and are thrown off during the process of suppuration, are replaced by a similar tissue, in which new bone is sparingly formed.

Sometimes one fissure exists alone, sometimes there are several; and, in the latter case, they may all start from one spot on a bone, or may be multiplied by the branching of a single fissure. They often terminate in a suture, which is then usually separated (*Diastasis*), but not unfrequently they are continued across the suture into the adjoining bone. They generally do not unite for a considerable time, and may, even after the expiration of a very long period, exhibit no tendency to union; the rough edges of the fissure are merely rounded off by absorption. If they should then heal, the void is filled up by fibroid callus, which unites with the pericranium and dura mater. They are seldom repaired by means of bony callus, on the contrary, they are sometimes fatal; for the inflammation and suppuration which occur in their vicinity, and in which the inner membranes and the brain become involved, destroy life, it may be, after a long period; or the same result ensues, sooner or later, from the various injuries which the brain and its membranes have sustained from the original violence. Large and numerous fissures are generally rapidly fatal, especially such as extend deep into the base, and those which take place from the skull being crushed.

A fall or a blow very frequently produces contusion, separation of the periosteum, or concussion of the bone at a circumscribed spot, while, at the same time, there may be no injury perceptible externally. The consequence is, that the periosteum inflames, pus or sanies is effused, and the outer lamella of the bone may die and exfoliate; or if the bone have been violently injured, it may inflame in its whole thickness, and the periosteum and dura mater with it, and pus or sanies may be produced, both upon the surface and in the substance of those structures: the bone then becomes discoloured, and has a dirty grayish-green appearance, all its pores are filled

with purulent or sanious matter, its surfaces particularly are rough, and seem corroded, and at length it perishes in its whole thickness. The inflammation of the dura mater very often spreads from its original seat to a considerable extent, and leads to the formation of numerous abscesses, which, after a time, become confluent, and also erode the vitreous table. At length the inflammation spreads to the inner membranes of the brain, or—the pus and sanies being taken up into the veins of the diploe,—either by meningitis or by metastasis, the injury proves fatal.

Openings in the skull, made with the trephine or by necrosis, are closed, as has already been remarked, by means of a fibroid plate, which usually ossifies incompletely or not at all. Complete ossification, when it does take place, always occupies a very long period.

The difficulty with which injuries of the skull are repaired by bony callus is worthy of remark; but the cause of the difficulty still requires a satisfactory explanation.

Fissures are sometimes met with in the cranial bones of new-born children, which extend several lines from the margin into the bone, and usually run a little obliquely through its thickness. It is important to mention them, in a forensic point of view, inasmuch as they bear considerable resemblance to the clefts and fissures which are produced by external violence, and may be confounded with them.

§ 6. *Anomalies in the Texture of the Cranial Bones.*

1. *Hemorrhage.*—Under this head, a disease is included which is of frequent occurrence in the skull of the new-born child, namely, the sanguineous tumour—thrombus neonatorum, cephalæmatoma,—a disease on which far too much has been written.

It consists of a circumscribed collection of blood, which is poured out beneath the pericranium, in sufficient quantity to form a swelling, that feels doughy or fluctuating. It is distinguished by its situation from the extravasations, which so commonly occur in the new-born child between the pericranium and the aponeurotic expansion above it; and by the quantity of blood extravasated, and the consequent swelling which is formed, it may be distinguished from another extravasation, which forms

a thinner layer, with an indistinctly defined margin, on the cranial, and especially on the parietal bones, and is extremely frequent, and indeed almost constant, in new-born children. This last extravasation is indeed of considerable importance, inasmuch as it is only a less degree of that hemorrhage which constitutes the thrombus.

The usual situation of cephalhæmatoma is the parietal bones, and, as it seems, particularly the right: on this bone, too, it attains its greatest size. It is found with less frequency on the frontal bone, and still more rarely on the occipital. Usually only one exists, and that on one or other of the parietal bones; but cases are not altogether uncommon, in which a second smaller thrombus is found on the frontal bone, and there may be even a third on the occipital. In size it may not exceed a hazel nut, or it may form a tumour extending over the whole parietal bone.

When cephalhæmatoma reaches a considerable size, its shape is remarkable. On the parietal bone, especially, it generally resembles a kidney: its greater and arched margin lies along the sagittal border of the bone, and its concave edge or hylus embraces the parietal prominence. Neither on the parietal, nor on any of the other bones, which have been mentioned, does it probably ever commence on the "punctum ossificationis," but always external to that point. Not unfrequently, however, it spreads over the punctum as well as the rest of the bone.

The cephalhæmatoma is constantly circumscribed near the margin of the affected bone, and does not pass beyond the sutures.

It is a circumstance of considerable importance, though it has hitherto been almost unnoticed, that in very many cases in which there is a collection of blood on the outer surface of the skull, there is also a corresponding extravasation between its inner surface and the dura mater. The inner accumulation is, as a general rule, the less extensive; but there are cases in which the reverse is the fact. Of course, if a bone be laid bare in this manner on both sides for a length of time, the prognosis is unfavorable.

Cephalhæmatoma originally is nothing more than an accumulation of blood beneath the pericranium: there is no essential

anomaly either in that membrane or on the bone : most of the blood is usually loosely coagulated, and is of a blackish red colour ; and a pale red fibrinous coagulum, stained with the colouring matter of the blood, frequently adheres to the inner surface of the pericranium and to the bone.

The examination of a recent thrombus is of itself sufficient to determine as to the truth or error of various statements and opinions that have been put forth, according to which cephalhæmatoma arises from certain anomalies in the development and texture of the bone, and to settle the true nature of the disease, and the source of the bleeding. Most of the hypotheses have been based upon examinations made at late periods of the disease, so that following in our description the course of the disease, we shall come in succession upon the various appearances which have been detailed, and which, though correctly observed, have been erroneously interpreted.

When the cephalhæmatoma has existed a short time, appearances are presented precisely similar to those that follow any separation between a bone and its periosteum. An inflammatory process commences, at the margins of the denuded part, and bony matter is deposited in the form of a velvety and finely-filamentous osteophyte. The osteophyte extends to a breadth of several lines beyond where the pericranium and the bone remain connected, but it is thickest just at the margin, and there forms an elevation, which rises abruptly around the denuded surface, but externally is gradually bevelled off. This exudation is what has been much spoken of as the bony margin of the cephalhæmatoma, and until quite recently was erroneously regarded as proving some original deficiency, or some loss from disease, of the outer layer of the bone at the base of the cephalhæmatoma. Upon the exposed bone, and inner surface of the pericranium, a fluid next exudes, which is at first gelatinous, but gradually becomes more dense ; and it may be observed that the bony margin, just spoken of, becomes continuous with the layer of exudation that adheres to the pericranium, while, at the base of the tumour, it meets that which covers the bone.

Should the extravasated blood be removed by absorption, or evacuated by an artificial opening in the tumour, the peri-

cranium and bone unite together in a simple manner by means of the exudation. But if this do not occur, a very remarkable appearance is presented in a few cases,—few, inasmuch as thenceforward the inflammation usually becomes suppurative. The layers of exudation covering the bone and the pericranium gradually ossify. The denuded surface of the bone and the inner aspect of the pericranium are then each covered with a very delicate and finely reticulated osseous stratum, and the extravasated blood is enclosed between them, and altered to a dirty or rusty brown colour. The ossification of both layers of the exudation is sometimes limited to particular spots, and sometimes partial ossification is met with only on that layer which lines the pericranium. In the latter case, plates of bone are found scattered over the surface of the tumour. The sanguineous tumour then exhibits a certain firmness, a kind of rigidity of its walls, and when firmly pressed gives an impression of crepitation like the crackling of parchment. This state of parts may lead to the error, that the outer table has separated from the bone, and adheres to the pericranium.

Far more frequently, when the swelling is not opened and its contents evacuated, the inflammation becomes suppurative, the extravasation changes to a chocolate brown, discoloured, fluid pulp, and ulceration or caries, and partial necrosis ensue. The pericranium is attacked with a similar inflammatory process, its inner surface is covered with purulent matter, and the bone becomes rough, unevenly exfoliated, and worm-eaten, and its pores and grooves enlarge.

If the tumour, when in this state, be not opened artificially, or if the pericranium and the other soft parts above it do not ulcerate and make a spontaneous opening in it, the caries which has already commenced at the denuded surface of the bone extends more deeply, an effusion of pus takes place beneath and loosens the dura mater, and at length the bone perishes in its whole thickness. Generally, when this takes place, the pericranium, and the soft integuments covering it, suppurate extensively, and become discoloured and easily lacerable. At such a stage as this, cephalhæmatoma generally proves fatal, sometimes by exhausting the strength, but more frequently by the extension of inflammation to the dura mater and inner membranes, and to the brain itself. The fatal result

is occasionally brought about by purulent matter being taken into the circulation, and by consequent pyæmia and metastasis.

But even when cephalhæmatoma has reached these advanced stages, a cure is sometimes effected. Healthy suppuration succeeds the evacuation of its contents, and the pericranium unites with the exposed surface of bone through the intervention of a layer of granulations, which afterwards ossifies. The portion of bone which the cephalhæmatoma occupied appears for a long time enlarged, thicker than natural, and somewhat uneven on its external surface, but in process of time this disappears. Even when an extension of suppuration here and there through the bone, and an effusion of purulent matter upon the dura mater, have produced necrosis, and a portion of bone has exfoliated, repair may take place; for granulations arise from the healthy bone which cover the dura mater, and uniting with those that spring from the pericranium, become a basement in which new bone is formed both at the margin of the opening and at other isolated spots.

When there is an effusion of blood upon the dura mater, as well as beneath the pericranium, the exposure of the bone on both sides renders the prognosis of course unfavorable, and the more so in proportion to the extent of the effusions.

Thus, then, cephalhæmatoma consists of an effusion of blood between a cranial bone and its pericranium, and frequently, at the same time, between the bone and its internal covering of dura mater also; and the source of the bleeding is the delicate blood-vessels which pass from those membranes upon and into the bone, and which have been ruptured.

Any essential anomaly in the development of the bone, or morbid affection of its texture, is merely an occasional and exceptional occurrence: the principal anomaly, when any does occur, is that isolated spots of the bone affected with cephalhæmatoma, or of some of the other bones composing the cranial vault, are thinner and softer than natural.

In a recent cephalhæmatoma, however, a manifest congestion of the bones of the skull is pretty constantly observed, and thin strata of extravasated blood may be noticed beneath the pericranium, near it. There is no question that the final rupture of the vessels is due to this congestion; and it is the more certain, from the fact that in ordinary cases there is

no other abnormal appearance to which the hemorrhage could be attributed. Moreover, the bone beneath the extravasated blood appears pale, especially when there is an effusion also on the dura mater; and this results from the emptiness of its vessels.

It is an interesting circumstance, that cephalhæmatoma sometimes coexists with effusions of blood between tissues, that have the same relation to each other as bone and periosteum. Thus peripheral apoplexy of a congested liver, or an extravasation of blood beneath its peritoneal investment, is not an unfrequent accompaniment of cephalhæmatoma.

In the great majority of cases, cephalhæmatoma most probably commences during birth, and increases to a palpable tumour soon afterwards. But instances do occur, in which the swelling is not perceptible till several days after birth; and there is nothing against the opinion, that it may form on the skull subsequently to the birth of the child. Its duration may extend over three or four months, or more.

It is most frequently found in first-born children.

2. *Inflammation, caries, and necrosis of the bones of the skull.*—The cranial bones are frequently the seat of these processes, which may be set up not only by violence, but by many other external influences; and very frequently by some internal cause. Sometimes, also, they are occasioned by a previous disease of the bone itself, or by inflammation, suppuration, ulceration, &c., of neighbouring parts.

I have stated, in my previous remarks, that inflammation frequently gives rise to an increase of bulk, to hyperostosis of the skull (p. 158). Syphilis, which is a very frequent cause of the enlargement, attacks particularly the frontal and parietal, amongst the bones of the skull, and the nasal bones and alveoli, in the face; and it very generally leads to extensive caries and necrosis. Caries and necrosis, when induced by tuberculous disease, are also observed on the frontal, parietal, and nasal bones; but they are more frequent at the base of the skull, especially in the body of the sphenoid.

As, on the one hand, inflammation may extend from the seat of these processes to the meninges and the brain, so on the other, are they sometimes themselves occasioned by inflammation of the membranous parts of the internal ear, or of the

narcs and adjoining cavities, or by inflammation of neighbouring ligamentous tissues and bones. Thus, for instance, caries of the occipital bone may be caused by inflammation and suppuration of the cervical vertebrae, and of their ligamentous apparatus, and the bones of the face suffer almost incredible devastations from so-called facial cancer.

3. *Expansion, softening, and consecutive isderation.*—Rickets not unfrequently, when met with in the infant, exists in a pre-eminent degree in the skull. It may be recognised by the great development of the prominences of the cranial bones, by the small denticulations and sinuous line of the sutures, and by the great thickness, the succulence, the cancellous expansion, the softness, and the great vascular fulness of the bones. It extends to the base of the skull, and, in a small degree, to the bones of the face also. The swelling of the wall of the skull effaces the inequalities of its inner surface, and it is remarkably smooth: the processes which are situated at the inner surface of the base of the skull, are unusually thick and smooth.

No less uncommon is that form of expansion (osteoporosis) resembling rickets, which affects the skull chiefly, and is indeed generally confined to that part, but which prevails at a later period of life than rickets, and occurs even in advanced age. It reaches, as has been already remarked, a very considerable degree, and terminates in a peculiar and very marked induration of the cranial bones.

When mollities ossium is general throughout the rest of the skeleton, it may affect the skull also; but it always does so in a subordinate degree.

4. *Adventitious growths.*—After the statements which have been made with respect to the occurrence of these growths in the osseous system generally, it is unnecessary, in this place, to do more than to remark, that cancerous growths do frequently form in the skull, as well on the calvarium as at the base: they may all be included, in brief, in the term '*Fungus Cranii.*' They are commonly supposed to be malignant, *i. e.* cancerous, diseases of the cranial bones; but the above-mentioned distinguishing term was given them at a time when an attempt was made to prove the existence and the origin of the same morbid growth in the skull, as had before then been considered peculiar to the dura mater, and had long been

named "*Fungus Durae matris.*" The two diseases may be readily confounded during life, especially when the disease of the bone commences in the diploe; for it breaks through the outer table as it grows, and spreads through an aperture bounded by bone over the surface of the skull.

SECTION II.—OF THE TRUNK AND ITS SEVERAL PARTS.

OF THE VERTEBRAL COLUMN.

§ 1. *Deficiency and Excess of Development.*—Deficiency of the whole vertebral column is met with only in monsters which are very incompletely developed; more commonly, only a portion of it is wanting. The latter deficiency occurs in cases of acephalus, and corresponds in extent with that of the concurrent defect in the neck or trunk. An allied but less deficiency, in which one or more vertebræ or half vertebræ are of small size, or altogether absent, sometimes co-exists with other malformations of the skull and vertebral column, with hemicephalus in the cervical portion of the spine, and with spina bifida: sometimes it is unaccompanied by any anomaly of the kind, occurring in persons who are otherwise naturally formed. In well-formed persons a cervical vertebra is sometimes, but very rarely, wanting; a similar deficiency in the dorsal or lumbar region is less unfrequent. Moreover, the absence of a dorsal vertebra is usually made up for by a supernumerary one in the loins, and the deficiency of a lumbar is supplied by an additional sacral vertebra. It is interesting to observe, in persons who are in no other way deformed, how the want of one half of a vertebra, in the same manner as a half too much, produces congenital lateral curvature.

A faulty and insufficient development of the spinal column may arise from an original fusion of the bodies of two or more vertebræ; this congenital ankylosis is sometimes associated with other malformations, especially with spina bifida and hemicephalus, but sometimes it occurs in persons who are otherwise well formed.

Fission of the vertebral column, spina bifida (Hydrorachis), is an anomaly of great importance belonging to this class. In

its nature it resembles hemicephalus, with which it is very frequently combined. It presents several degrees, which are discernible on the skeleton of the vertebral column: sometimes it involves the whole, sometimes only parts of the spine; and its extent, when partial, varies greatly. In its least degree, the half arches are developed, and occupy their natural situation; but, as they have not united, an aperture or fissure remains in the proper seat of union, the length of which depends on the number of vertebræ involved. In a higher degree, the half arches are incompletely developed, more or less of their extremities being deficient, and thus the fissure has a greater transverse diameter than in the preceding degree: usually, also, a larger number of vertebræ is affected. In a condition allied to this, the half arches are fully developed, but stand off from each other to a considerable extent, and are so turned round to the side of the bodies of the vertebræ, that the line of their direction becomes, at length, continuous with the posterior surface of the bodies: they are usually then flattened from before backward; and, as in the form already mentioned, are here and there united with one another. Although there is no actual deficiency of development, the fissure becomes very wide, and diminishes in depth. In a still higher degree, the fissure involves not the half arches alone, but also the bodies of the vertebræ; and, in the highest degree of all, one of the half arches may be wanting, and a part, or even the entire half, of one or of several of the bodies. Fission of the vertebral column in its whole length, or of its cervical portion, scarcely ever occurs, unless hemicephalus and hydrencephalocoele exist also. The most common situation of spina bifida is the lower dorsal and lumbar region. Fission of the sacral vertebræ is more rare: sometimes it occurs in two places together, and then usually one fissure is in the neck, and combined with hemicephalus, while there is another in the lumbar or lower dorsal region.

Excess of development is exemplified in the presence of an unusual number of whole or half vertebræ. In the former case, there are sometimes thirteen dorsal, or six lumbar vertebræ; the vertebral column is, to a corresponding extent, longer than natural; and, connected with the supernumerary dorsal vertebra, there is an additional rib. An excess of one or more halves of vertebræ occasions a congenital lateral cur-

vature, in the same manner as a deficiency of halves of vertebræ; and it constitutes a most remarkable instance of scoliosis, of which I shall treat more at large hereafter.

§ 2. *Anomalies in the form of the Vertebral Column, and of its several Parts.*—Deficiencies of development involve, as has been stated, various anomalies in the shape of the several vertebræ, and also, as will further appear, deformities of the whole column. Moreover, the approximation to each other in form, which the vertebræ exhibit at the limits of the natural divisions of the column, sometimes gives the appearance of a vertebra being deficient. In this manner the last dorsal assumes much of the character of a lumbar vertebra, and more frequently the last lumbar becomes a sacral bone: this transference from the lumbar to the sacral region may be symmetrical, and occur on both sides, or may take place on one side only. On the contrary the first lumbar may approach a dorsal vertebra in character, and sometimes it bears the rudiment of a thirteenth rib: or the first sacral vertebra may resemble the last lumbar. Finally, the vertebræ are subject to manifold deformities at different periods of life, in consequence of exostosis, osteophyte, and partial absorption, of the cicatrization which succeeds the loss of substance occasioned by caries and necrosis, &c.

Some of the deformities of the vertebral column are congenital; others, and those the greater number, come on at different ages after birth, and consist of various forms of curvature of the column. Those of the former class are for the most part occasioned by so serious affections of the central organs of the nervous system (hydrorachis combined with anencephalus, encephalocele, &c.), that they very rarely come under observation at the later periods of life. The deformities produced by high degrees of fission of the vertebral column, and the curvatures which accompany them, are instances of this kind. In other cases the curvature of the spine, and the other deformities co-existing with it, are produced by the contraction of muscles, to which certain diseases of the nervous centres give rise. Sometimes the curvature results from deficiency of the lateral half of a vertebra, or from unequal development of the two halves of the column, or from the presence of one or more half-vertebræ too many. Lastly,

fission of the thorax or abdomen, or *eventration*, may make the spinal column deviate from its natural direction. The form of the deviation may vary; it may be a simple curvature, or, as is the case with those which come on after birth, it may be a compound of two or more curves, &c.

I venture to introduce in this place the description of three cases of original deformity of the spinal column: they are of rare occurrence, and the first of them is perhaps unique.¹

CASE I.—*Compound Scoliosis, occasioned by the presence of supernumerary lateral halves of vertebræ, which compensate each other.*—The spine of a woman, æt. 46, a very old preparation in the Museum at Vienna, but unfortunately not made with care proportioned to its value.

The sacrum and coccyx are united into one bone, on the right side of which there are four sacral foramina, and five on the left; for the first sacral vertebra is higher on the left side than on the right, and, as is evident, from its left spinous and articular processes being double, it consists on that side of two lateral halves of vertebræ fused together. The fifth lumbar is developed on the right side to a sacral vertebra, and thus the height of the left half of the sacrum is level with the right.

The first lumbar vertebra, in the concavity of the lumbar curve on the left side, appears very depressed, being not more than eight lines in height, and is concave from above downwards; while on the right side it is convex, and more than two inches high, and has a horizontal groove filled with an ossified intervertebral body, which indicates that it is double on that side. On the left side there is but one half arch, on the right there are two; there is also a small supernumerary intervertebral foramen on the same side (the right), and a half spinous process which has no fellow.

This odd half spinous process alters the position of the bodies of the vertebræ, and more particularly of their spinous processes above and below, in such a manner, that the laminæ, more or less displaced and overlapping, terminate in a row of unsymmetrical spines. Inferiorly, the derangement stops at the second lumbar vertebra; but above, it reaches to the eighth

¹ Oesterr. Med. Jahrb. vol. xix.

dorsal; the right half spines of the first and second lumbar vertebræ lie beneath those of the left side: but the right half spines of the twelfth, eleventh, tenth, ninth, and eighth dorsal, are placed above those of the left side; hence they either appear unsymmetrical, or here and there one of the right half spines comes in contact with the left one of the vertebra next above.

The left half of the seventh dorsal vertebra, on the convex side of the inferior dorsal curve, is very high; it is pretty distinctly marked with a horizontal fissure in the same way as the first lumbar vertebra, and has two half arches instead of one, just as the first lumbar has on its right side. The lower one, which is the thicker, unites with the single arch that exists on the right side, and both together form a complete spinous process; the upper one terminates in an odd spine. There is an intervertebral foramen between the double arches, which is rather smaller than the foramina adjoining it above and below. The sixth dorsal vertebra has an apparently odd arch on the right side, which is adapted to the supernumerary half spine of the seventh dorsal vertebra, while the left arch, as will presently appear, is shrunken and combined with the corresponding arch of the fifth.

Between the sixth and fifth dorsal vertebræ, on the right side, (at the convexity of the upper dorsal curve,) another, a fourth, half vertebra is intercalated, which has a half arch on the right side. Its spinous process unites with the combined left half spines of the fifth and sixth dorsal vertebræ.

The fifth dorsal has an arch, the left half of which (at the convexity of the upper dorsal curve) is increased in breadth by union with the left half arch of the sixth dorsal. It has but one transverse process, and it unites with the half arch of the intercalated half vertebra to form one very broad, flat, spinous process; while it forms another, and more slender one, with the corresponding right half arch of the fifth.

The half arches of the fourth dorsal vertebra lie one over the other, the left uniting with the slender spinous process of the fifth (fifth and sixth), whilst the right terminates in a half spine.

The third dorsal is tolerably well formed; but the right half arches of the second and first coalesce, and their single

spinous process joins with that of the left half arch of the second, while the other half of the first terminates again in an odd spine.

According to this, therefore, there are in the dorsal, lumbar, and sacral parts of the column, four half vertebræ, with their half arches and processes, too many. They are so placed on the two sides as fully to compensate one another; for upon the duplication of the left half of the first sacral vertebra there follows duplication of the right half of the first lumbar: and then, as the left half of the seventh dorsal is double, there is half a vertebra interposed on the right side between the sixth and fifth dorsal. And with regard to the arches,—the half arches of the sixth and fifth dorsal coalesce on the left side, and those of the second and first dorsal on the right.

Lastly, as has been already pointed out, there result from the position of the abnormal half vertebræ the following curvatures of the whole column:

α. Curvature of the sacrum, with the convexity towards the left, in consequence of duplication of the left half of the first sacral vertebra: the development of the fifth lumbar vertebra to a half right sacral compensates this curve.

β. Slight curvature in the lumbar and lower dorsal regions, in consequence of duplication of the right half of the first lumbar vertebra: the convexity at this part is directed towards the right.

γ. Considerable curvature in the middle dorsal region produced by the left half of the seventh dorsal vertebra being double: here the convexity is towards the left.

δ. Considerable curvature in the upper dorsal region, which is caused by the half vertebra interposed between the sixth and fifth dorsal vertebræ: the convexity here faces the right. The last two form a very compressed S curvature; and the vertebræ are twisted upon their axes, and project backwards (kyphosis).

Corresponding to the anomalies in the vertebral column, there are some very remarkable peculiarities in the number, form, and attachment of the ribs. As there are two supernumerary half vertebræ in the dorsal region, one on the right side, and the other on the left, that is, one supernumerary dorsal vertebra, and the number of articulating surfaces on

the bodies and transverse processes being in accordance with that number of vertebræ, there should be thirteen ribs on each side; but there is another attached to the seventh cervical vertebra, and there are actually fourteen more or less complete ribs on each side.

The first rib on the left side is attached by two heads, the upper one of which articulates with the seventh cervical vertebra just above its lower border, and the lower with the first dorsal; the two heads unite in a single neck: the tubercle divides, and is applied to the transverse processes of the seventh cervical and first dorsal vertebræ; and the rib then ends in a single shaft. The first rib on the right side is also attached by two heads: the upper, which is the thicker, and has a cloven neck, joins the seventh cervical vertebra opposite the upper head of its fellow; the lower head is more slender, but sinks deeper into an excavated articulating fossa between the first and second dorsal vertebræ. The three necks soon unite into a single broad one, which is attached by one tubercle to the transverse process of the seventh cervical vertebra, and by two others to a very large articular process on the coalesced right half arches of the first and second dorsal vertebræ; it then separates into two distinct shafts.

The third and fourth, or rather, if we enumerate by the heads of the ribs, the fourth and fifth, ribs on the left side have but one neck, and for a short distance also, only a single body. At the single, very thick transverse process of the united left half arches of the fifth and sixth dorsal vertebræ, two ribs are attached, namely the sixth and seventh.

Moreover, ankylosis has taken place between the odd half arches and the bones next adjoining them, between several of the bodies of the vertebræ, especially in the concavity of the curvatures, and also between the second and third cervical vertebræ.

CASE II. *Scoliosis produced by Deficiency of one Half of a Vertebra.*—The spine of a tailor 70 years of age.

It consists of the cervical skeleton (excepting the atlas), of twelve half dorsal vertebræ on the left side, and eleven on the right, of four abdominal and four sacral vertebræ.

The six inferior cervical vertebræ form one curved hump:

their bodies and articular processes are united, each to each, into one piece, of coarse cellular structure, the anterior surface of which looks as if the bony material had been poured over it in a fluid state and had then coagulated; while a tense, and partly ossified, ligamentous tissue, stretches down over the arches.

The sixth and twelfth dorsal vertebræ form the extremities of a slight curvature to the left, in the concavity of which (on the right side) there is half a vertebra wanting. For only the left half of the ninth dorsal vertebra exists, which is united to the eighth dorsal, and with it composes one very high body and a similar half arch on the convex side of the curve. There are two transverse processes of nearly equal size upon the half arch, and two spinous processes which lie one above the other, but are fused together.

All the dorsal vertebræ, from the sixth to the twelfth, are connected together, anteriorly, by a mass of bone, partly cellular and partly compact, which is most abundant over the intervertebral bodies, and looks as if it had been poured out upon them. Their articulations, also, are more or less completely ankylosed.

The spinous processes of the last two (the third and fourth), lumbar vertebræ, and the left transverse processes of the second and third, are driven upwards by a deviation of the sacrum considerably backwards and a little to the left; and the third and fourth spines are, at the same time, pressed together. The last lumbar is converted into a sacral vertebra.

The sacrum curves strongly backwards and to the left; it consists of four vertebræ; the last two of which, especially on the right side, in consequence of the displacement of the anterior and posterior sacral foramina from their natural positions, resemble a sieve perforated with large holes.

CASE III. *Angular Curvature (kyphosis), produced by the twelfth dorsal Vertebra consisting of two divided lateral halves.*—The spine of a woman, æt. 55. The two portions form triangular rudiments inserted laterally between the eleventh dorsal and first lumbar vertebræ, with their points directed inwards; and they are united with the first lumbar in such a manner, that its body is very high at the sides, whilst in the

middle it seems low, and is in contact with the eleventh dorsal. In consequence of this deficiency in the mesial line, the vertebral column is bent backward at a very obtuse angle. The arch of the divided twelfth dorsal vertebra is completely united into one piece with that of the first lumbar; but the half spines of the latter are so twisted, that the right one appears to be higher than the left. The last right rib is connected, by two heads, with the twelfth dorsal vertebra.

The curvatures which are acquired may be divided, as they are naturally, into the three cardinal forms; of curvature to either side, lateral curvature—*scoliosis*; curvature backwards, or angular curvature, the hump—*kyphosis*; and curvature forwards, sinking of the back—*lordosis*. Scoliosis, as will be seen in the sequel, may be combined with the other two curvatures. Moreover, it is of importance to distinguish the primary deviation from those which are consequent upon it, and compensatory.

a. Scoliosis is by far the most frequent of the three. There is sometimes only one curve; but more commonly a second, a compensatory inclination towards the opposite side at some other portion of the spine renders the deviation sigmoid: in some cases there are several curves, and in others the scoliosis is combined with obliquity of the pelvis. When the lateral curvature is double or sigmoid, it is usually the dorsal region and the lumbar that are bent; and though the primary curvature may be in either region, it is far more frequently in the dorsal than in the lumbar. And further, the deviation in the dorsal region inclines most frequently towards the right side; whilst the compensatory curvature in the lumbar region to the left is itself compensated by a corresponding obliquity of the pelvis. In order to make even the little that has been said intelligible, as well as the statements which follow, it is necessary to point out the chief causes of scoliosis.

Attention has already been directed to the deviation of the spine which results from original inequality in the lateral halves of the vertebral skeleton. It is that to which Guérin attributes those cases of hereditary scoliosis which become perceptible between the ages of 7 and 10 years, and are generally unaccompanied by any trace of a rickety constitution. There is also a curvature to which the female sex is liable, in which Guérin

ascertained that a disproportionate growth, or elongation of the vertebral column, takes place at the period of puberty. But lateral curvature of the spine may come on at various periods of life subsequent to birth, under other conditions, which are as follow :

a. Active muscular contraction, arising from some idiopathic and substantive, or from a secondary, affection of the nervous system, especially of the nervous centres, and usually combined with other deformities of the skeleton, contractions, palsies, &c., which also owe their origin to muscular contraction.

β. In most cases it arises from neglecting or impeding the action of the muscles of inspiration of one side. All the scolioses traced by Stromayer to paralysis of the muscles of inspiration on one side are of this class, as well as those in which the spine is bent in consequence of chronic pleurisy, and narrowing of one side of the thorax. In such cases, the primary curvature is at the dorsal part of the column ; and as, in most occupations, it is the left side of the thorax, the function of which is impeded or neglected, the spine inclines far more frequently towards the right side than towards the left.

γ. The curvature may be a consequence of rickets: the pelvis, deriving some one-sided deformity from the lower extremities, propagates it to the vertebral column. The first curve is then in the lumbar region, and that in the dorsal region is consecutive, and slighter than the other.

δ. Lastly, scoliosis may ensue after a one-sided deformity of the pelvis has been produced by dislocation of either femur upwards, whether the dislocation be the result of violence or of disease (spontaneous).

Every considerable lateral curvature is accompanied by a twisting of the vertebræ upon their axes ; and this rotation or torsion is of importance in reference to the diagnosis. The vertebræ are always turned towards the curved side, that is, the bodies face the convexity, and the spinous processes the concavity of the curve: that vertebra is the most rotated which forms the most prominent point of the curve, and, for the same reason, the spinous process of the same vertebra is the deepest in the row of distorted spines. Upon these facts Guérin rests the solution of the problem, from a given curvature of spinous processes to determine the degree of deviation of the vertebral bodies.

This rotation of the vertebræ upon their axes produces the deviation of the vertebral column backwards, and the rounded hump which are the peculiar result of lateral curvature (*excurvation* of Bampfield). It is a compound distortion, which has been named *kyphosis scoliotica*; but which, inasmuch as the lateral curvature—the scoliosis, is the primary evil, would be better called *scoliosis kyphotica*.

The changes which take place in the several vertebræ and their processes, as well as those in the ribs, become more palpable in proportion to the degree and the duration of the lateral curvature. The vertebræ on the side of the concavity are less deep than natural; sometimes they scarcely measure one third of their normal height; they slope considerably from above downward, their margins seem pressed forward, and their form, in short, bespeaks their having undergone gradual compression. The intervertebral bodies are more or less wasted, and sometimes are entirely removed: when this is the case, the vertebræ at last become ankylosed. The processes in the concavity of the curvature become slender; they are frequently elongated, pressed together, and flattened against one another, and the articular processes are ankylosed. And the ribs, in like manner, attenuated, compressed, and flattened where they adjoin the vertebral column, become ankylosed to the vertebræ and to one another.

b. Curvature of the vertebral column backward presents itself either as an arching of its dorsal portion, a morbid excess of the natural curve in that region (*excurvation* of Bampfield), or in the form of the hump,—*kyphosis*, *gibbus* (angular curvature, angular projection of Bampfield). The former is a common occurrence in old age, or in consequence of *mollities ossium*; the latter, which is more the subject at present under consideration, is produced almost always by inflammation and caries, but sometimes by fracture of the bodies of the vertebræ, or by inflammation and suppuration of the intervertebral bodies. With occasional exceptions we may say, with Meckel, that this curvature is more important in proportion as there are fewer vertebræ affected, though the greatest curvatures are those in which whole vertebræ on the bent side are destroyed in considerable numbers, and those which remain are united to one another.

The most common situation of the disease is the lower dorsal and upper lumbar regions, though it does occur also in the upper dorsal, and even in the cervical and the lowest part of the spine.

Not unfrequently the lateral halves of the diseased vertebræ are destroyed unequally: the upper part of the column will then incline to one side.

c. Curvature forward—lordosis—is met with in greatest extent and frequency in the lumbar region: it scarcely ever occurs as a primary curve in that situation, but is almost always consecutive upon some previous one, compensating, as such, the obliquities of the pelvis produced by rickets, congenital lameness, or coxalgia on both sides. It is sometimes not limited to the lumbar region; but occurs, as a consequence of considerable angular curvature, in other parts also. Lastly, it sometimes comes on in the course of diseases of the spinal cord and of palsy, and extends the whole length of the vertebral column. Sometimes, when it is consecutive upon deformities of one side of the pelvis, arising from rickets or coxalgia, a certain amount of lateral curvature is combined with it.

Every primary curvature is compensated by a second curve in the opposite direction, which generally occupies the part of the column immediately adjoining the first; not unfrequently the second is succeeded by a third, and that even by a fourth. Upon this fact depend the various consecutive deformities which the pelvis presents in regard to its form, symmetry, and position. In cases of lateral curvature, not only is the primary deviation in the dorsal region, followed by a lumbar curve in the opposite direction, or *vice versâ*, a primary lumbar by a dorsal curve, but the primary curvature reaches along the column in extended sequence, in such a manner, that the second curve is compensated by a third, and this again not unfrequently by a fourth. The following condition is quite common:—a primary curvature to the right in the thoracic portion of the spine, is followed by another to the left in the lumbar region, and the rotation of the vertebræ corresponds with the amount of the dorsal curve. But the sacrum exhibits a deviation, which commences, perhaps, at the lowest lumbar vertebra, and takes an opposite direction to that of the lumbar curve; that is to

say, the sacrum appears lower than natural on the left side, and higher on the right, and betrays the rotation of its component vertebræ towards the side opposite to the lumbar curve, by projecting into the pelvis on the left side deeper than on the right. Lastly, in many cases the coccyx projects in an opposite direction to the curvature of the sacrum, and forms a fourth deviation of the column.

In another case, a primary deviation of the sacrum of a rickety pelvis to one side and backward, (inclination of the pelvis on one side to an unnatural degree,) may be counterbalanced by a curvature of the lumbar vertebræ to the opposite side and forward (*lordosis scoliotica*), and this, again, may be equalized by a dorsal curve in the contrary direction.

The amount of the compensating curvature generally equals that of the primary curve: but to this there are frequent exceptions; and the second curve may at one time be quite subordinate to the primary, at another may considerably exceed it.

Kyphosis, or the angular projection, which is formed by two sides of an angle, is counterbalanced by a curvature forward (*lordosis*). The compensation is sometimes effected chiefly by the upper, sometimes by the lower part of the spine: as a general rule, it is the longer side of the angle by which the balance is restored; though sometimes its two sides are equally curved. These compensatory curves, again, whenever it is possible, become the occasion of further curvatures in the opposite direction; and the cervical vertebræ and sacrum, by their projection backward, make up for the deviation of the adjoining regions forward.

The compensation in *Lordosis*, or curvature forward, is obtained in two ways, according as it arises from too great inclination of the pelvis, or from angular projection in the dorsal region. In the former case, the natural curvature in the dorsal region is slightly increased; in the latter the sacrum, and therefore the pelvis, incline backwards.

When there is a combination of lateral and angular projection, or of lateral, with a primary curvature forwards, the form of the compensatory distortions of course corresponds with those of the compound primary curves.

Distortions of the spine diminish the capacity of the two

great cavities of the trunk to such an extent as materially to interfere with the development and free action of the thoracic and abdominal viscera, while they also produce various changes in those organs, as regards both their position and their form: but the most serious consequences are those which ensue from extreme lateral and angular curvatures, as such distortions narrow and deform the thorax, and impair the functions of the lungs, and consequently of the heart. They occasion an increase of density in the tissue of the lung, and thereby give rise to active dilatation of the right side of the heart, and enlargement and permanent congestion of the whole venous system,—cyanosis. And hence, though a contrary opinion is very commonly entertained, they establish that general immunity from tuberculous disease, of which I have already spoken.

The deformities of the thorax and pelvis resulting from curvature of the spine are so intimately associated with the subject before us, that they must be treated of at once; and it will add to the interest with which we shall enter upon the study of the distortions of the pelvis in general, and more especially of the consequent curvatures of the spine, when we can refer again to our present conclusions, and find how the results of analysis in the two cases agree.

1. *Thorax*.—The most extreme deformity presented by the thorax is that which occurs in lateral curvature, and in the combination of lateral with angular projection. It seems displaced in the opposite direction to the convexity of the dorsal curve, and the whole, or more commonly the lower end only, of the sternum, swerves from the mesial line in the same direction; the axis of the thorax itself inclines towards the convex side of the dorsal curve. One consequence of this deviation is, that that half of the thorax which is on the convex side of the curve is lower than the other, and approaches the pelvis; when there is considerable curvature, the false ribs touch the ilium, or even project into the iliac fossa. But in extreme cases of combined lateral and posterior curvature (scoliosis kyphotica) in the lower dorsal region, the thorax assumes the contrary position; the ribs which pass from the concavity of the curve force the chest to the opposite—the convex side; the sternum diverges in the same direction, and

the sunken half of the thorax is that on the concave side of the curve.

Moreover, both sides of the thorax are flattened; and the amount of flattening is proportioned to the extent to which the vertebræ are twisted on their axes, and consequently to the size of the hump; but it is always most marked on that side of the chest which corresponds to the concavity in the spinal curve, and which may even be indented, while the other side is somewhat vaulted. The ribs take a more direct course outwards and forwards in proportion as they emerge from the deeper part of the concavity. They lie closer together, too, on that side, and may even be ankylosed at their posterior extremities; while those on the other side, especially about their tubercles, describe an arch which, when the vertebræ are very much rotated, encircles the bodies of those bones. Moreover, they lie further apart; in fact, their posterior extremities are separated from each other in exact proportion to the amount of the axial torsion of the vertebræ. Hence arises this difference between the two halves of the thorax; that on the concave side of the spinal curve is narrower from before backward, but has greater capacity laterally, while on the side of the convexity it has the converse dimensions: and again, the perpendicular measurement is shortened on the former side, and lengthened on the latter.

The condition of the shafts of the several ribs accords with these facts, more particularly with that which has been last mentioned. On the side of the concavity they are rounded, or rounded and angular; on the side of the convexity they are unusually flattened and ribbon-like; but however likely it might seem from the appearance of the ribs, yet no difference can be detected by the most careful measurement in the length of the several ribs and cartilages of the two sides.

In angular curvature the chest has a different character,—that is, as I have already remarked, in angular curvature in the lower dorsal and upper lumbar regions. In the first place it is thrown upwards; the anterior extremities of the upper ribs rise considerably higher than the posterior, so that the upper, and still more the lower, ribs form an arch which is convex upwards. The consequence of this elevation of the chest is, that its perpendicular diameter is curtailed, whilst from before

backward its dimensions are increased. The sternum preserves its relations to the bent column in the mesial line, but is thrown forwards; and as a consequence of the elevation of the anterior extremities of the ribs and of their arch-like vaulted form, it is thrown more forward the more it is depressed. The sides of the chest vary in shape according to the situation of the projection, and the acuteness of its angle. When it is in the lumbar region and moderately acute (94°), the ribs take a considerable lateral curve, and the chest is barrel-shaped; but if a projection in the same situation should form a more acute angle (60° for instance), and the column above, which includes the dorsal region, should be thrown much backwards; or if the projection should occupy the lower part of the dorsal region itself, the wrong direction of that part of the column in which the dorsal region is included, whether it be one leg of the angle or both, will give a different form to the sides of the chest: for those ribs which pass from the angular projection of the column will run a straighter course than the others, in order to reach the projecting sternum, and the sides of the thorax at that part will be flattened; while above the angle the chest will be vaulted in the way first mentioned. Should the angle be extremely acute (55°), the sternum will bend backwards at its lower end, and become slightly arched, as if its greater depression removed it too far for the ribs to reach it, even by their new and more direct course.

The thorax, in every instance, approaches very close to the pelvis, and may even rest upon it: the abdomen, therefore, is much shortened.

This, however, is a rule which the thorax does not follow in a very acute angular projection in the upper dorsal region, or when the curvature is situated low in the loins. For in a specimen of the former description, in which the nine upper dorsal vertebræ were destroyed, I found the ribs closely packed together at their posterior extremities, but considerably depressed and straightened anteriorly; so that the thorax was flattened laterally, its axis much inclined, and the sternum thrown forwards. The compensatory curvature of the column forward was so great that, in spite of the depression of the thorax, the distance between it and the pelvis was nearly

natural. In an example of the latter kind, the thorax was elevated; but the very great amount of curvature forward in the remainder of the lumbar, and the whole of the dorsal, regions, and the pendulous protrusion of the abdomen (compare the state of the thorax in curvature forward) contracted the perpendicular diameter of the chest, while the considerable vaulting of its walls laterally, enlarged its transverse dimensions. (Compare the remarks upon this case below in reference to the pelvis.)

In those cases of angular curvature in which the vertebræ are destroyed to a greater extent on one side than on the other, and in which, besides that the bones approximate on that side, it also happens, that the column above the angle is rotated on the axis of the vertebræ towards that side, and that the hump projects in the opposite direction; the thorax inclines towards the side on which the vertebræ are most destroyed, and sinks deeper on that side towards, and even into, the cavity of the false pelvis; while the sternum is depressed towards the same side as the hump; a compound, in fact, of lateral and angular curvature—scoliosis and kyphosis—produced by carious loss of substance, which may be named *kyphosis scoliotica*.

The state of the thorax is different again in curvature of the lumbar region forward, and in the excessive inclination of the pelvis backward, with which the lumbar curve coexists, and to which it is due. The chest is increased in length, and while the breadth of its lower part is strikingly greater than natural, it is very pointed above, and flattened from before backward. This remarkable form, especially the increase in length, is probably due to the abdominal muscles being stretched by the excessive inclination of the pelvis.

2. *Pelvis.* The deformities of the pelvis in curvature of the spine are, in many respects, still more remarkable, and an acquaintance with them is, at the same time, more important. They are frequently the primary deformity, and the spinal curvature is the consecutive; but even independently of these cases, they are not, as Meckel asserts, uncommon: on the contrary, they are so frequent, that it may be regarded as an exception to find a completely normal pelvis where there is any curvature of the spine.

In the great majority of cases the following deviations may

be recognised with tolerable distinctness, and they may all be explained according to fixed rules.

The pelvis is always oblique in lateral curvature of the spine, and exhibits a want of symmetry in its two halves that is sometimes striking. The half of the pelvis on the side opposite to the upper or dorsal curve is higher than the other; the extremity connected with it appears shortened; that is to say, the several parts of the two limbs being of equal length, and the necks of the two femurs placed on a level with each other, the trochanter, the knee, and the heel on that side are higher than those on the other side: the elevated half of the pelvis inclines less than it should, and is, at the same time, narrow; the transverse diameter of the inlet, therefore, is greater than natural. The circumstances from which these changes appear to arise are twofold. In one respect they are due to a change in the position of the sacrum, which is both curved and rotated on its axis towards the side opposite to the lumbar curve. The consequence of the former—the curvature—is, that the os innominatum is somewhat lifted at the sacroiliac joint; and the latter—the rotation—carries the posterior part of the bone into the cavity of the pelvis: the adjoining portion of the ilium follows; but, as the innominatum is fixed at the symphysis pubis, the linea arcuata bends near the sacroiliac joint, and thus diminishes the capacity of this half of the pelvis in its antero-posterior diameter, at the same time elongating its transverse dimensions. But further, it is sometimes perceptible at the first glance, that the narrowness of this half of the pelvis is partly due to the flattening of so much of it as is anterior to the acetabulum. The reason of this flattening is found in the lumbar curve transmitting the weight of the body principally to the limb of that side. The linea arcuata then stretches in a straighter course from the angle already formed in it to the pubes, and the distance between the iliopectineal eminence and the promontory is diminished.

When, in consequence of combined lateral and angular curvature (*Scoliosis kyphotica*) in the dorsal region, the compensatory lateral curvature of the loins bends forward to a corresponding degree, the dimensions of the pelvis are narrowed still more; for the promontory, on the one hand, projects further into the upper aperture on the side of the curve, and as, on

the other, the weight of the body is still more directly transferred to the neck of the femur on that side, the ileo-pectineal eminence is pressed inward and upward to a greater extent.

Observation of the character of the supplemental curvatures, therefore, enables us to predicate the deformity of the pelvis which exists in lateral curvature of the spine: the dimensions of its cavity are altered on the side opposite to the upper or dorsal projection, or on the same side as that to which the lower, or lumbar curve, or the spinous processes of the upper curve are directed.

Now and then, however, there are exceptions to this rule. Some very decided lateral curvatures of the dorsal region, which project considerably beyond the centre of gravity of the body, are continuous with a lumbar column which is, proportionally, much less curved; and the weight of the body, therefore, is transferred to that side of the pelvis which the dorsal hump overhangs. The innominatum on that side is then the higher, although the other changes which result in narrowing of the pelvis are still found, as in ordinary cases, on the side opposite to the dorsal curve. When beneath a lateral curvature to the right, in the upper part of the back, there is a curve in the lower dorsal and upper lumbar region to the left; and this is succeeded by a third deviation of the column in the lower part of the loins to the right, while the sacral vertebræ swerve again to the left; and when in such a case the second curve is greater than the rest, the left half of the pelvis will bear more of the weight of the trunk, and will stand higher, and have less inclination, than the right; while the deviation of the sacrum will give rise to the usual narrowing of the pelvis on the right side.

The pelvis, in angular curvature, is generally very capacious; its height is considerable, and the predominant diameter is manifestly the conjugate; the inclination varies, but usually—that is, when the projection occupies the usual situation in the lower dorsal, and adjoining lumbar regions—it is very decided.

This conformation of the pelvis chiefly arises from the diminution in the size of the abdominal cavity, which is produced by the depression of the thorax: the difference in its inclination depends especially upon the extent to which the compensatory curve projects forward. For the angular projec-

tion consists of two legs which diverge, under varying angles, from each other, one upward and the other downward. The greater part of the compensatory incurvation falls to the one or to the other of these legs, according to the situation of the projection; and the inclination of the pelvis varies with the distribution of the duty of compensation.

If the angle be situated in the lumbar region, the small remainder of the column in the loins, which forms its lower leg, is insufficient to counterbalance the projection backward, and there is no need of any further deviation in the pelvis, for the upper leg, which runs up to the dorsal part of the column, undertakes the compensation, and curves gently forwards. The inclination of the pelvis is then nearly natural.

The lower leg of an angular projection, situated in the inferior dorsal region, is longer, and needs a more decided receding of the sacrum for its support. The inclination of the pelvis is then greater than natural.

When the angular projection is situated high in the dorsal region it is counterbalanced principally by curvature of its lower leg; and the sweep forward in the dorsal and lumbar region necessitates a still more marked inclination of the pelvis.

But, when the projection is in the lowest part of the lumbar region, the state of the pelvis is just the opposite. The rest of the vertebral column then forms the upper leg of the angle, the sacrum alone forms the lower. The pelvis is raised to a degree corresponding with the size of the angle, and the level of its upper aperture may even become horizontal; its inclination is annihilated, and the projection can be counterbalanced only by anterior curvature of the spinal column. If the number of vertebral bodies destroyed be considerable, it results as well from the loss of substance as from the elevation of the pelvis, that the trunk is shortened, and its two cavities narrowed; and a further consequence is, that the thorax acquires a peculiar shape. In the trunk of a woman, of 34 years of age, who died in childbirth, from rupture of the uterus, and who had had a difficult labour five years before, the spine was found projecting at an obtuse angle, in consequence of carious destruction of the bodies of the four lower lumbar vertebræ. The dorsal portion of the column from that point upwards, described a slight

curve arching downward, while the sacrum, very flat and straightened, and constituting the lower leg of the angle, had raised the pelvis so much, that it had lost its inclination almost entirely, and that the distance of the upper margin of the symphysis pubis from the ensiform cartilage, was scarcely $3\frac{1}{4}$ inches. The antero-posterior diameter of the thorax was much contracted (compare page 240), so that the ensiform cartilage was not more than $3\frac{1}{2}$ inches distant from the lower margin of the eighth dorsal vertebra, which was over against it: the transverse diameter, however, measured more than $9\frac{1}{2}$ inches. The reason of this was, that as the upper leg of the angle could alone undertake the compensation, the abdomen, being exceedingly narrowed from above by the anterior curvature of the column, and from below by the elevation of the pelvis, was thrust forward, and became pendulous, and the thorax was flattened from before backward, as in an ordinary anterior curvature in the lumbar region, by the same action of the abdominal muscles as resisted the expansion and sinking of the abdomen. It is worthy of notice that, without a close examination, so pendulous an abdomen might lead to the inference that the inclination of the pelvis was increased.

The ordinary anterior curvature in the loins involves a corresponding displacement of the pelvis backward, that is to say, excessive inclination of it; and more especially when the lumbar curve is itself compensatory and consequent upon too great inclination of the pelvis. When it arises from rickets it is always associated with diminution of the conjugate diameter of the pelvis; and when it is combined with lateral curvature also, the two halves of the pelvis are unsymmetrical.

But in some cases in which the lumbar vertebræ sweep forward into the pelvis, not only is there no increase in the inclination of the pelvis, but on the contrary, there is scarcely any, or none at all. Such cases are proved by what has been remarked already, and by the cause from which they generally arise, to be instances of angular projection in the lowest part of the lumbar region, which are compensated by anterior curvature of the upper leg of the angle.

§ 3. *Solutions of Continuity,—Dislocation,—Anchylosis.*—

Various kinds of solution of continuity are met with in the vertebral column as results of external violence; and their characters are those of incised, punctured, or gunshot wounds, according to the instrument by which the injury was inflicted. The accidents to which the spine is most subject, however, are fracture of the bodies of the vertebræ, and laceration of the intervertebral cartilages. Though sometimes broken longitudinally, the bodies are much more liable to transverse fracture; very commonly, one or several vertebræ are found comminuted, and the line of fracture runs in various directions. The injury which the spinal marrow sustains in these accidents usually renders them speedily fatal; but sometimes it may be observed, after death, that the fragments have begun to unite together by means of a scanty production of callus: it is extremely rare to meet with a specimen in which union has been completed. Fractures of the odontoid process of the axis present considerable interest; for in a few rare cases they have not only not proved fatal, but have even existed a considerable time without union of the fragments. A specimen of this kind is contained in the Vienna Museum.

The intervertebral substances are usually lacerated only when one or more vertebræ are at the same time broken or crushed.

The lateral articulations of the vertebræ are more rarely dislocated in proportion to their distance from the occiput and two upper cervical vertebræ.

Anchylosis is sometimes found in the spinal column at the time of birth, but it more frequently comes on later in life. The union takes place sometimes between the bodies of the vertebræ, the adjoining margins and surfaces of which are then connected together, and sometimes between their lateral articulations: it is also very common to find anchylosis in both situations. When the bodies are anchylosed, it may be by the union of their surfaces, which meet each other when the intervertebral substances have been removed by absorption or by inflammation and suppuration; or, it may be by a deposit of new bone at their margins, which passes, like a bridge, across the interspace between the bodies, and incloses the intervertebral substance in an osseous capsule; or, again, by a mass of bone (*osteophyte*), which seems as if it had been poured,

when fluid, along the front of the vertebral bodies, and, then coagulating, had united them into one piece. Each kind of deposit forms transverse swellings between every two adjoining vertebræ: sometimes they grow, too, on the back of the column, and then they may prove dangerous, from their pressure on the cord (Key). Anchylosis of the lateral joints of the column may, of course, come on when the bodies are fixed in the manner just described; and it may take place between the atlas and axis, on the shortened side, in long-standing cases of wry-neck. It may also result from inflammation and supuration of the articular structures, from caries, and so forth.

§ 4. *Hyperostosis, — Atrophy.*—Hypertrophy of the osseous structure of the spinal column never occurs to an extent at all to be compared with what is observed in the skull: sometimes only, in opening a vertebral canal, we may meet with some difficulty, in consequence, apparently, of the bony tissue being more dense than usual. Exostosis, too, is rarely found: when it does occur, its texture is generally cellular. If it spring from the back of the bodies of the vertebræ, and encroach upon the spinal canal, it may lead to serious consequences. The bridge-like osteophyte situated at the margins of the vertebral bodies, and that more abundant one which seems poured out upon them, are both commonly confounded with exostosis.

Atrophy of the vertebræ takes place, for the most part, only when there is general wasting of the whole skeleton. When it is a local affection, it is produced by aneurisms of the thoracic and abdominal aorta, and goes on to an extreme degree: the front and sides of the bodies of the vertebræ have, in some few cases, been completely eroded, and the spinal canal opened.

§ 5. *Diseases of Texture.*—Congestion of the bodies of the vertebræ is sometimes observed in the lower dorsal and lumbar part of the column, and it usually occurs when the vertebral plexus of veins is dilated and swollen; it is sometimes only an habitual distension unconnected with other disease; but more frequently it is produced mechanically by disease of the heart and lungs.

Inflammation of the vertebræ is a disease of frequent occurrence, not only in the young, in whom it is most observed,

but also in adults. Indeed, old age is not exempt from it. Any portion of the column, or even any single vertebra, may be the seat of inflammation; but the parts mostly affected are the upper cervical vertebræ, and, next in frequency, the lower dorsal and the adjoining upper lumbar vertebræ. It is very commonly the primary disease, but sometimes it is brought on by previous inflammation and suppuration of the ligamentous apparatus of the column, and of the intervertebral substances. In most cases, it runs a chronic course, very often it is of tubercular nature, and terminates in caries and necrosis. When this is the case, matter usually forms and collects near the column, especially on its anterior surface; and, in favorable cases, opens externally: the track of the matter is sometimes very long, and the external opening far distant from the disease. The carious destruction may then be repaired by ankylosis, and by the column falling together at an angle, corresponding to the quantity of substance lost: but far more frequently the disease exhausts the patient, the symptoms usually showing that the spinal cord and its membranes suffer in some way or other. Thus the cord itself may be compressed from the tumefaction of the ligamentous apparatus, from the protrusion of an abscess into the canal, from dislocation of fragments, or of the whole, of a vertebra, or by the products of circumscribed inflammation of the dura mater of the cord; or it may be bent and irritated at the spot where the angular projection is beginning; it may waste, or circumscribed inflammation may take place in it, or diffused inflammation in its membranes, &c. Moreover, when the upper cervical vertebræ are carious, the odontoid process, being set free from its own ligaments, may, by a sudden turn of the head, tear through the inflamed and softened ligament and the dura mater, which confine it behind, and projecting naked into the canal, may crush the spinal marrow. When the upper dorsal vertebræ are carious, the abscess sometimes opens into one of the bronchi, and matter and necrosed fragments of vertebræ are discharged through the air passage. Caries of the abdominal part of the column is very often combined with what is called psoas abscess.

Rickets in the spine may be distinguished by the peculiar change which it effects in the texture of the bones, and by

the curvatures produced in it by rickety deformity of the pelvis. As there is generally more distortion on one side of the pelvis than on the other, the curvature in the loins is usually directed forwards, and to one side.

It has already been remarked, that all the bones of the trunk are subject to *mollities ossium*, but especially those of the spine. It occasions different deformities, both of the pelvis and of the vertebral column, according to the particular condition of the patients. They are, for the most part, bedridden, so that the usual effects of the disease are an arched incurvation of the whole spinal column and elevation of the pelvis, produced by the pressure upon the sacrum and tubera ischii.

On the subject of *adventitious growths*, reference may be made to what has been already stated; those chiefly met with are tubercle and cancer. The former is of very frequent occurrence; it gives rise to extensive caries and necrosis of the column, and to the various consecutive appearances and terminations which have been pointed out as those of inflammation of the vertebræ. Cancerous deposits are more rarely met with in the vertebræ than in other bones. The same relations obtain, between cancer of the vertebræ and fungus, as it is called, of the spinal dura mater, as between the same disease in the cranium, and in the dura mater within the head: the former, when situated in the bones, may spread to the spinal dura mater, and the fungus of that membrane may reach from its original seat to the vertebræ, and become a fungus of bone.

THE THORAX.

§ 1. *Deficiency and Excess of Development.*—The full growth of the thorax is arrested in various degrees in monsters which are very incompletely formed; especially in those which are also acephalous or anencephalous, or which are born with spina bifida. The malformation of the thorax is in these cases associated with a corresponding deficiency, or a small and ill-developed state of the lungs and heart, and with hernial protrusion of those organs. It may arise either from partial absence of the spine, from fusion of some of the dorsal vertebræ together, from deficiency or incomplete development of the ribs,

or from fission of the thorax and abdomen; and it consists in diminution of size and capacity, and generally, also, in misshapen exterior.

But, sometimes, persons, otherwise well formed, lack one dorsal vertebra, and one—generally the twelfth—rib; in a few instances, indeed, one or more ribs are found wanting, even when the number of vertebræ is complete. Occasionally, though there may be a proper complement of ribs, one of them is too short, and instead of reaching the sternum, it ends in a pointed cartilage.

Now and then there is no sternum, or only a part of it exists; or it is fissured at one spot, or in its whole length. The last condition is just indicated in some well-formed persons, whose ensiform cartilage is split or perforated, or in whom the lateral ossific centres in the body of the sternum remain separate for a long time. When the bone is wanting altogether, its place may be supplied, and the thorax closed by a firm fibrous membrane; otherwise, whether the opening be formed by a total or partial absence, or by a mere fissure of the sternum, the thoracic organs will protrude. Moreover, the bone may be unnaturally short, small, narrow, or the like.

In those double monsters in which the point of junction is the thorax, that part is found developed to excess. It is preternaturally developed likewise, when there is more than the proper number of ribs. Sometimes the supernumerary rib is borne upon a thirteenth dorsal vertebra, sometimes upon the first lumbar, while, in rare cases, the seventh cervical vertebra has a rib connected with it, which may either terminate by a free extremity, or become attached to the sternum, or to the true first rib. Some ribs are so broad as to appear double; others are fissured at different parts; while others, again, are forked at their anterior extremities, &c.

§ 2. *Deviations from the natural Size and Form of the Thorax.*—

The chest is subject to several other varieties in *size*, or capacity, besides those which have been already mentioned: some of them are faults of original conformation, and are either connected with peculiarity in the general organization of the individual, or have a more immediate relation to some anomaly in the viscera of the trunk; while others arise from disease of

the lungs, or pleura, or of the respiratory muscles. Whether the deformity be one of enlargement, or contraction, it may affect the two halves of the chest nearly or quite symmetrically, or it may be confined to one half, or even to a still less portion of it; but the change of form is greatest, when it occupies only a half, or a still smaller section, of the chest. The following are the principal deformities.

In some men the whole skeleton approaches, in its general form, the type which is characteristic of the female; and the thorax, as well as the pulmonary organs, are of small size. This individual peculiarity is the more marked, in proportion as the abdomen, more particularly, resembles the largely-developed abdomen of the woman. On the other hand, men are met with now and then, whose chests are disproportionately large and capacious.

Contractions of the chest, both when they are symmetrical, and when confined to one part, are observed in cases of pneumonia in which the lung is wasted, in catarrh and dilatation of the bronchi, in tuberculosis and tubercular phthisis in the lung, in pleurisy, and in paralysis and atrophy of the inspiratory muscles at the upper, anterior, and lateral parts of the chest, &c.

Dilatations ensue from emphysema of the lung, from pleuritic effusion, pneumothorax, and considerable effusions into the pericardium, from enlargement of the heart, dilatations of the aorta, large growths in the chest, &c.

The varieties in the *form* of the thorax present more interest than those of mere size, though the two are combined in numerous ways.

It is unnecessary to repeat, though it is desirable to refer to, what has been said with regard to the deformities of the thorax connected with curvatures of the spine: the chief of those which remain are as follow:

The compressed and shallow chest, flattened from before backwards, which the clavicles and projecting shoulders overhang like wings, and which expresses the phthisical constitution. There is no question, that a thorax of this form is often associated with a peculiarity of the whole organization; but it is the latter, and not the form of the thorax, which predisposes to tubercular disease of the lungs. What such a chest loses

in breadth, and vaulted form, it gains in length; its capacity is by no means necessarily deficient, nor is that of the lungs within it; and that such a form of chest gives a predisposition to phthisis, is quite hypothetical.

The thorax is sometimes flattened, or even depressed, in the subclavicular regions, and thus obtains the phthisical form. This change is a consequence of wasting of the pulmonary tissue in the vicinity of tubercles, or of closure of vomicae in the apices of the lungs: it also sometimes results from pleurisy in the same region.

In general emphysema of the lungs, the chest is enlarged, and acquires a vaulted barrelled shape.

After the subsidence of chronic inflammation of one whole pleura, the corresponding half of the chest becomes flattened; or it may even sink in and form a kind of pit. If the pleurisy have been confined to a part of the membrane, a similar deformity takes place, but occupies only that portion of the chest. In the former case the ribs fall in, especially at their anterior extremities, and lie so close together along their whole length, that the interspaces between them are obliterated; and the diameter of the chest is diminished on that side in every direction. The consequence is, that the dorsal vertebræ curve towards the opposite or sound side of the chest, and that a curvature of compensation takes place in the lumbar region; at a later period of life it may even be found that the deviation of the spinal column has reached the pelvis and rendered it oblique.

There is a remarkable deformity of the chest which is known by the name of pigeon-breast. The cause of it is an attenuated condition of those muscles of inspiration which are situated at the upper, anterior, and lateral regions of the chest, viz., the pectorales and serrati; and it is very frequently, though not constantly, combined with rickets of the thorax. The chest is flattened laterally; and very frequently it has even a longitudinal depression towards the anterior extremities of the bony ribs, while the sternum, with the costal cartilages, strongly curved, projects considerably in front (*pectus carinatum*). The spine is either straightened, or presents a slight excurvation. The diaphragm becoming hypertrophied, carries on the respiration, and makes up for the diminished breadth of the chest by increasing its vertical diameter. The depression of the dia-

phragm considerably augments the size of the abdomen externally; and as the latter circumstance has chiefly arrested the attention of observers, it has led to numerous misconceptions as to the true theory of the disease. The ribs frequently bear the clearest marks of rickety disease of their tissue; and even in life the enlargement of their anterior extremities may be easily perceived.

Another, and an important deformity of the thorax, is that in which it becomes narrowed and cylindrical, and, at the same time, elongated. The change arises from paralysis of the intercostal muscles, and is produced by enlargement of the inferior intercostal spaces. It has been named by Engel the paralytic thorax. (Oesterr. Jahrb., April, 1841.)

The contraction of the thorax which takes place in old age, is sometimes allied to one, and sometimes to the other of the two last-described deformities.

The chest sometimes becomes misshapen in consequence of following certain employments and trades: thus shoemakers have a depression at the lower end of the sternum.

Amongst the peculiarities of the several parts of the chest, there are still those of the ensiform cartilage which require notice. The most remarkable is the inversion of a long processus ensiformis.

§ 3. *Solutions of Continuity.*—Fractures of the ribs are of serious moment, from their sometimes injuring the pleura and lungs, and even the pericardium and the heart. Single fractures, for the most part, unite readily, but when several successive ribs are broken, false joints are sometimes formed between the tumours of callus thrown out around their fragments. Fractures of the sternum are usually transverse; they seldom occur unless the ribs or spinal column are injured at the same time.

§ 4. *Hyperostosis, Atrophy.*—The spongy exostosis sometimes presents itself on the ribs and sternum as an example of hyperostosis. Atrophy of the ribs is commonly well marked in tabes senilis of the skeleton; and both ribs and sternum are frequently worn away, and even perforated by the pressure of aneurisms of the ascending part, and arch of the aorta.

§ 5. *Abnormal changes of Texture.*—Caries and necrosis are frequently met with in the ribs and sternum. They are often produced by empyema and suppuration in the pleura, by the softening of tubercular lymphatic glands, by vomicae of the lungs arising from tubercle, &c. The inflammation and induration which occur in syphilitic disease are rarely met with in the sternum.

Morbid growths are rather frequent both in the sternum and ribs; and they present the various forms of enchondroma, tubercle and tuberculous caries, and of cancer: the last may be a consequence of the degeneration of that disease in the adjoining glands of the chest, or a substantive new growth in the bones themselves.

THE PELVIS.

§ 1. *Deficiency and Excess of Development.*—There are various ways in which arrest of development is manifested in the pelvis. Sometimes the sacrum and coccyx are defective, or altogether absent, or they are stunted in their growth. At other times, one or both of the innominata, or a part of one of them, is wanting, there being at the same time no lower extremities; or a fissure existing in the abdomen may be continued down to the pelvis, and lay open the symphysis. In the siren-monster the lateral parts of the pelvis are fused together.

Allied to this is a pelvis which is of diminutive size, either from its own original conformation, or in consequence of defective growth of the sexual organs or rectum.

Excess of development is exemplified in double monsters, in whom it reaches various degrees.

§ 2. *Deviations of the Pelvis from its natural Size and Form.*—Amongst the former are included specimens in which the pelvis is unnaturally large or wide in all its diameters, as well as those in which it is unnaturally small or narrow in the same respect. As pelves, which are unusually large or small in any one diameter, are generally in an opposite condition in some other dimensions, they will be treated of under the head of deformities. And small pelves, more especially, not only bear traces of their growth having been arrested in consequence of

rickets, but they are, at the same time, also misshapen. We shall meet with various instances of such pelves amongst the following deformities. The essential characters of a rickety pelvis are, that it is small, *i. e.* low and contracted, especially in the conjugate and oblique diameters of the inlet; its capacity is small, its inclination considerable, and the arch of the pubes is widened. When this fundamental anomaly is extremely developed, or unequally on the two sides, it will be specially noticed as of rickety origin when it occurs in the following description.

As the importance of the subject of deformity of the pelvis arises chiefly from its connection with the mechanism of parturition, the principal interest is centered in the upper aperture or inlet. The great number of facts relating to the subject can best be arranged according to Oslander's division of deformed pelves; but, as that division does not include every deformity, it must be somewhat enlarged, by the addition of several subordinate varieties, and by the interpolation here and there of an intermediate form.

Oslander enumerates six forms.

1. That in which the pelvis is elliptical in its transverse diameter: the ilia are widely separated from one another, and, as on the one hand, the promontory of the sacrum encroaches a little forward, and, on the other, the pubic bones are flattened, the conjugate diameter is less than natural, and the transverse measurement increased.

2. The kidney-shaped pelvis, in which the great projection of the upper part of the sacrum produces a deformity of that figure at the inlet.

There is a form of pelvis intermediate between these two, in which the base of the sacrum runs straight across the back of the inlet, and the linea arcuata bends forward from it at an angle.

3. That pelvis, the upper aperture of which may be compared to a figure of ∞ . The extreme projection of the promontory on the one side, and the sinking backward of the symphysis and horizontal rami of the pubes on the other, produce a deformity in which the upper aperture appears divided into two lateral spaces, which are united by an intervening isthmus.

These deformities of the pelvis, with scarcely an exception, are always occasioned by rickets.

4. The pelvis, which is oval or elliptical in its conjugate diameter, the antero-posterior measurement exceeding the transverse. I have met with a deformity of this kind combined with angular projection of the spine.

5. The oblique pelvis. This class includes by far the greatest number of misshapen pelves. Its characters are as follow: the ileo-pectineal eminence approximates unnaturally to the promontory on one side; that half of the pelvis has a diminished oblique diameter, it stands on a higher level, and inclines less than the other. The causes which lead to such a change of form are lateral curvature and torsion of the sacrum, and straightening and encroachment inward of so much of the linea arcuata as lies between the acetabulum and symphysis. It is a class which includes those frequent deviations from the natural form of the pelvis that arise from lateral curvature, and the yet more frequent primary deformities induced by rickets, as well as those which result from dislocation of one hip, whether in consequence of violence or from previous disease of the joint. Of the last, which is the most common cause, I shall speak further presently.

The pelvis is sometimes oblique at the time of birth, but much more frequently it becomes so afterwards. There is much interest attaching to those congenital obliquities of the pelvis, which originate in faulty formation, as contradistinguished from those which are produced by disease in the fœtus. One of these, in particular, has been described by Nägele, under the name of the obliquely-contracted, or obliquely oval, pelvis.

The deformity so named, is founded in congenital ankylosis of one sacro-iliac synchondrosis, and in arrested growth of the lateral mass of the sacrum, and of the ilium on the same side.

The principal other characters of the obliquely-contracted pelvis arise out of these two; and in two specimens in the pathological collection at Vienna (in both which the anomaly is on the right side), they are seen to correspond in all particulars with Nägele's lucid description: they are as follow:

The sacrum appears displaced towards the ankylosed side, and its anterior surface is turned more or less in the same direction; the symphysis pubis is driven towards the other

side, and therefore lies obliquely, not directly, opposed to the promontory.

The lateral wall of the pelvis on the side adjoining the anchylosed part is flatter and straighter than natural.

On the other side, the line which separates the greater from the true pelvis, is less curved than usual in its posterior half, but more so anteriorly; this anomaly, together with its remote consequences, is often found also in obliquities that come on after birth.

Hence it follows, that the pelvis is obliquely contracted from the sound sacro-iliac joint to the opposite acetabulum, whilst the measurement between the anchylosed synchondrosis and the acetabulum, on the healthy side, is not only not diminished, but is greater than usual:

That there is less distance on the side of the anchylosis than on the sound side, between the promontory and the vicinity of the acetabulum, and between the point of the coccyx and the ischial spine:

That the posterior superior spine of the ilium is further removed from the lower border of the symphysis pubis on the anchylosed than on the articulated side:

That the walls of the pelvic cavity converge somewhat at their lowest part in an oblique direction, and that the arch of the pubes is more or less narrowed:

And that the aspect of the acetabulum on the flattened side of the pelvis inclines rather forwards, while on the other side it looks almost directly outwards.

In the specimens preserved in the Vienna Museum, the lumbar part of the vertebral column is distinctly curved towards the abnormal side of the pelvis.

There is another form of unsymmetrical pelvis, which is allied to the preceding, but subordinate to it in degree, and generally indeed is only just discernible. The deformity is found in persons in whom the last lumbar has on one side been converted into a sacral vertebra. The inequality in the pelvis consists in its greater capacity on the side of the anomaly in the lumbar vertebra, the linea innominata of that side describing a larger and shallower curve, and being more inclined than its fellow. The opposite half of the pelvis is in the contrary state; and with that state is combined a slight

curvature and rotation of the vertebræ towards the less capacious side,—an anomaly which is remarkable for the analogy it bears to the condition of the pelvis in lateral curvature, and which is constantly found in the lumbar region of the spine whenever its last vertebra is thus converted into a sacral. In cases in which this peculiarity in the last lumbar vertebra exists on both sides, the projection of the promontory is very slight, the conjugate diameter is great, and the inclination of the pelvis considerable.

Almost all the obliquities of the pelvis which come on after birth are of rickety origin. We have seen that when the sacrum, and consequently the pelvis, incline too much backward, and the latter is at the same time narrowed symmetrically, a compensatory curvature forward, a genuine lordosis, takes place in the lumbar region. In the same manner, when one side of the pelvis is contracted in consequence of a deviation of the sacrum from its mesial direction, the anterior curvature in the loins inclines somewhat laterally towards the contracted side. Thus the obliquities of the pelvis, in cases of rickets, are at once the starting point and the occasion for lateral, or more commonly antero-lateral, curvatures in the loins; and these are succeeded by supplemental deviations of the dorsal part of the column towards the opposite side and backwards. Such is the state of the spine when the deviation is a compound one; and the conclusion to which an analysis of it leads is the same, so far as regards the deformity of the pelvis, as that which was elicited by an examination of the condition of the pelvis in primary lateral curvature: in both cases, the abnormal half of the pelvis is on the side opposite to the dorsal curve of the spine.

6. *The triangular pelvis.*—When the amount of this kind of deformity is slight, the inlet of the pelvis forms a triangle, with its angles rounded off, and the sacrum for its base. In a higher degree of it, the sides of the triangle become convex, and encroach upon the pelvic cavity, and after a time the base projects inward too; the three sides then unite at very acute angles, and the upper aperture of the pelvis acquires the shape of a heart on playing-cards. The deformity may even go farther; both sides of the triangle, or it may be one only, approximating to the base so much as to bring the promontory into contact, and even into union with them, just above the acetabula.

The triangular pelvis is the extremest instance of contraction. The ilia are so compressed from before backward that their venter becomes a narrow fissure; the symphysis pubis forms a beak-like prominence; the arch of the pubes narrows considerably, and may even be obliterated; the tubera ischii approach each other; and as the promontory and the lumbar part of the spine sink down into the cavity of the pelvis, the sacrum beneath presents a curved anterior surface, or may be bent at an angle.

The triangular pelvis is, for the most part, a result of mollities ossium; but it is an error to ascribe it exclusively to that disease. Mollities ossium may undoubtedly be the cause of every decided and advanced degree of triangular pelvis, but minor degrees of it are sometimes due to rickets. In extreme cases there is less inclination of the pelvis than usual, and it is sometimes even raised above the horizontal line.

The form and position of the pelvis undergo an interesting change after so-called coxalgia: for the dislocation of the femur upward and backward, which takes place in that disease, when it occurs only on one side, destroys the symmetry of the pelvis in a remarkable manner, and renders it oblique; and the same change occurs when the dislocation is the result of violence. The general characters of the deformity are, that the whole os innominatum becomes wasted and small, the ilium assumes nearly a vertical direction, the upper aperture becomes enlarged, and the pelvis acquires an abnormal inclination. In other respects its characters present many varieties which may depend upon the extent of the displacement, upon the condition of the joint as to mobility or ankylosis after the diseased process has ceased, or, supposing the limb to have been moveable, upon its having been used afterwards or not.

a. In cases of coxalgia on both sides, in which a layer of more or less dense fibrous tissue binds a remnant of the head of the femur, or the stump of its neck, to the upper margin of the wasted acetabulum, and in which, therefore, some mobility of the limb remains, the ossa innominata are attenuated, especially at the pubes and ischium, and the whole cavity of the pelvis is enlarged. The latter change is partly due to the attenuation of the bones; but it can be traced, at particular parts of the pelvis, to other circumstances. The inlet is enlarged

by the curve of the *linea innominata* becoming shallower, and by the disappearance of the *ileo-pectineal* eminence, and of the angle at the *sacro-iliac synchondrosis*; the cavity of the pelvis increases in size symmetrically, at the expense of the basis of the wasted acetabula; and the very striking dilatation of the outlet is due to the separation of the ischia from each other. This separation of the ischia is attributed by Hülshof to the action of those rotating muscles of the femur which arise from the *tuber ischii*; for, as the whole weight of the body falls on them, they draw the ischia outwards, and, consequently, asunder. The angle beneath the pubes thus becomes obtuse, and may even be changed into a shallow arch. The ilia assume nearly a vertical position, partly in consequence of the abdominal muscles attached to them being stretched by the sinking of the pelvis, and perhaps, also, from the pressure of the displaced head, or stump of the femur, against the upper part of their outer surface.

The wasting and enlargement thus described, diminish the height of the pelvic cavity, and the length of its axis; the pelvis itself is depressed, and has a greater inclination than natural, and the lumbar part of the spine forms an arch, directed forward, which varies in degree, according to the amount of the inclination of the pelvis.

β. In cases in which similar changes have been produced by *coxalgia* in the articular structures of the hip, but on one side only, the *os innominatum* of that side becomes thin, and in consequence of some flattening and sinking of the *linea arcuata*, and of a distortion of the sacral and lumbar vertebræ, which has yet to be described, the inlet of the pelvis is enlarged on the same side. The capacity of the pelvis is also increased; but the size of the outlet varies, according as the limb connected with the diseased joint has been used or not. If it have been used, the corresponding *tuber ischii* projects outward, and the dimensions of that side of the outlet are increased; but if not, the weight of the body, in walking and standing, will have been sustained, in whole or in part, by the sound limb, while the actions of the diseased joint will have been assisted, or quite supplied, by the use of a stick or crutch. The *tuber ischii*, in that case, is not everted; but, on the contrary, the wasting which accompanies the process of

repair, the shrinking of the acetabulum, the angular bending of the os innominatum, and, in many cases, the inward direction which is given to the femur while the patient is lying in bed, and which is afterwards retained, all tend to force the tuber ischii inward, especially towards the coccyx, and thus to contract the outlet of the pelvis on the side of the disease.

Moreover, the ilium on this side becomes so nearly vertical, that the distance between its anterior superior spine and the upper border of the symphysis pubis, is manifestly lessened: the height of the same half of the pelvis is diminished; it is depressed, that is to say, its inclination is greater than that of the other side; and the sacrum is both inclined backward on the side of the diseased joint, and rotated towards it. The two halves of the pelvis, therefore, are not symmetrical; and the error of symmetry will increase, in proportion as the acetabulum of the sound joint is driven inward and upwards, to receive the weight which the curved spinal column directs upon it;—in proportion, that is, as the pelvis becomes contracted on the sound side, while it is enlarged on the diseased. The difference between the two sides will increase, too, so long as the bones continue soft.

As the curvature of the vertebral column, which has been referred to, is for the purpose of compensating for the obliquity of the pelvis, it is directed forward and towards the side opposite to the coxalgia, that is, towards the healthy, or narrower, half of the pelvis. It is a curvature which compensates for the deviation of the sacrum, and if it be itself considerable, it is followed by a curvature in the dorsal region towards the opposite side. In this, again, we find a correspondence with the rule laid down as to the relation of deformities of the pelvis to primary lateral curvatures, that the pelvis is contracted, &c., on the side opposite to the dorsal curve.

γ. When the morbid process has ended in complete ankylosis, the linea arcuata and the bottom of the acetabulum, on the diseased side, become not only flattened but angular; in fact, the whole os innominatum, wasted in all its separate parts, bends at an angle projecting outward, which is formed in the seat of the old acetabulum,—in the osseous cicatrix corresponding to the previous disorganization. The ilium inclines inward and forward, the ischium inward and backward; the promontory encroaches on the healthy side of the pelvis;

and as the symphysis pubis is drawn by the angular distortion of the innominatum towards the side of the disease, the linea arcuata of the healthy side runs in a straight direction forward to reach the displaced symphysis.

δ. Under certain circumstances, which have not as yet been clearly ascertained, the pelvis is found to have all the anomalies, already mentioned, as results of coxalgia, but to be elevated, and to have less inclination on the diseased side; although, at the same time, the extent of the consecutive luxation is not greater than that which has been presumed in the foregoing description, nor has the process terminated in a different manner. (Compare Guérin.)

ε. On the other hand, it certainly happens after complete dislocation upward and backward upon the outer surface of the ilium, whether it be the result of violence, or have occurred in the course of coxalgia, that the pelvis is raised, and has less inclination on the diseased side. This peculiarity was attributed by Guérin to the action of the stretched psoas and iliacus muscles: and there may be observed, at the base of the anterior inferior spine of the ilium, a more or less distinct impression or furrow, which has been made by the pressure of the common tendon of those muscles. The same condition is found when the disease terminates in ankylosis, after having destroyed the head and neck of the femur. The small trochanter is drawn upward against the border of the acetabulum, and is also turned backward by the inversion of the limb.

Besides those deformities of the cavity and the outlet of the pelvis, which either accompany, or may be inferred from the abnormal states we have already considered, there are several others of independent origin. They depend chiefly upon the sacrum, whether it be too much flattened or too much excavated, upon unusual projection of the coccyx inwards, upon excessive width or narrowness of the arch of the pubes, &c.

§ 3. *Deviations from the healthy Condition of the Articulations of the Pelvis, and Solutions of the Continuity of its Bones.*—There are various circumstances under which the synchondroses are liable to become more or less loose. Not only may they be torn asunder by considerable mechanical violence, but, in pregnancy, the firmness with which they connect the bones is

slightly diminished, the fibro-cartilages becoming succulent, soft, (and vascular?) : in the act of parturition the fibro-cartilages may be very much stretched, and even partially separated from the bone. When puerperal diseases of a very malignant type come on after labour, the cartilages may be partly or entirely removed by the destructive suppuration, and the bones thus separated from one another.

On the other hand, the bones of the pelvis may be too closely connected together, and ankylosis may take place between them. It is usually effected by bridge-like processes of bone which pass from the margin of the articular surface of one bone to that of the other, and as it were enclose the fibro-cartilage in a kind of capsule : it very rarely happens, that there is any union of the articulating surfaces themselves ; and it is not ascertained whether, when that is the case, the fibro-cartilages themselves ossify, or whether, as is more probable, new osseous matter is formed on the articulating surfaces of the old bone, whilst the fibro-cartilage is absorbed. Ankylosis of the sacro-iliac joint is met with now and then, but it is rarely found at the pubes.

Fractures of the pelvis do not generally take place without very considerable external violence, such as a fall from a great height, being run over, or buried beneath falling earth. They seldom unite without permanent displacement of the fragments.

§ 4. *Hyperostosis, Atrophy, and Diseases of the Texture of the Bones of the Pelvis.*—With the exception of those osteophytes, which form on the pelvis, in consequence of inflammatory processes, or caries in the hip-joint, we find hyperostosis but rarely in the pelvic bones : whilst atrophy, especially of one half of the pelvis, is frequently met with after coxalgia and the several dislocations of the femur.

Caries and necrosis occur in the pelvis, chiefly as consequences of disease in the hip-joint ; they arise sometimes also from the pressure of the bed, from the suppuration of lymphatic glands, muscles, &c.

Rickets and mollities ossium occasion the deformities of the pelvis already described.

On the subject of adventitious growths it may be mentioned, in addition to what has been stated already, that the caries

which comes on in the bones of the pelvis is frequently of tubercular nature; and that cancer occurs in them, not only in the form of primary tumours, which sometimes attain a great magnitude, and have an abundant bony skeleton, but also, secondarily, by the advance of cancer from the rectum, uterus, or vagina.

OF THE EXTREMITIES.

§ 1. *Defective and Excessive Development.*—The former class includes those cases in which one, or more, or all of the extremities, or some part of one of them, is wanting, or in which their development is arrested. In the upper extremity it may happen that there is no humerus, or that one or both of the bones of the fore-arm are absent, or, if present, are in a rudimentary state. The hand will then be found articulated to the humerus, or to the scapula, according to the special deficiency of the intermediate bones. The hand itself may not exist at all, or only a part of it may be developed. In the case of partial deficiency of the hand, a correspondence is observed, both in the carpus, the metacarpus, and the fingers, with the character of the defective development in the fore-arm: when the radius is wanting, the thumb and forefinger, with so much of the carpus as belongs to them, are wanting too; and the other fingers, and their carpal elements, do not exist when there is no ulna; but when either bone of the fore-arm is in a rudimentary state, some trace of the corresponding part of the hand, an incomplete finger, for instance, can also be found. Again, the hand may terminate at the metacarpus, or in one or more incompletely-formed fingers; and, lastly, in some cases, a fusion of the bones of the metacarpus and fingers is observed.

Deficiencies of the same kind occur in the skeleton of the lower extremities. Only in them a peculiar fusion of the bones takes place, which is known by the name of the Syren monstrosity. The bones, in this case, are also rotated on their axes forward.

The chief instances of excess of development are those in which supernumerary fingers and toes, or the last phalanx of an additional finger or toe exist: they occur in persons who

may be otherwise well formed. The development of additional long bones and limbs, whether complete or incomplete, indicates a tendency to duplication in the whole body.

§ 2. *Morbid Varieties in point of Size.*—Under this head may be included that disproportion in length affecting all the limbs, or the thoracic or abdominal extremities only, which dates from the period of their original formation: it is of most importance when it affects the bones of a single extremity or of one segment of an extremity. Thus the humerus or one of the bones of the forearm may be found shortened in a remarkable degree, and in the latter case some anomaly will exist in the articulation of the carpus, &c., to the fingers and toes: sometimes a bone exceeds its natural growth, and reaches a monstrous and disfiguring size.

A bone is liable to an interruption of its growth at any period, or it may be the seat of atrophy; in either case, the whole, or part, of an extremity, will present an instance of acquired smallness of size. Instances of this kind are frequently met with after exhaustive processes of disease and repair, either in bones or in the soft parts adjoining them, after inflammation and suppuration in them, fracture, caries, necrosis, and rickets, after unreduced dislocations, neuralgia, paralysis, &c.

§ 3. *Deviations of Form.*—These are very numerous, independently of those which arise from defect or excess in the original formation of the bones. The bones are variously misshapen in dwarfs, in cases of hyperostosis, after the loss of substance produced by caries, from osteoporosis, &c.; and their form is altered still more after fractures which have united with the fragments displaced, and after permanent dislocations; but the most remarkable deformities of all are the various bendings and curvatures of the long bones which are produced by rickets, &c., especially in the lower extremities.

§ 4. *Solutions of Continuity.*—Every form of solution of continuity is exceedingly common in the bones of the extremities, but fracture is the most so. The whole subject has been considered in general already, and it only remains to

treat in particular of fractures of the neck of the femur and of the patella.

Fractures of the neck of the femur are, for practical purposes, divided into those within the capsular ligament and those external to it. The former may occupy any spot intermediate between the head of the bone and the insertion of the capsular ligament. Its plane is sometimes transverse, but more commonly it is oblique: in the latter case, it either runs through the base of the neck near the insertion of the capsule, or, which is more frequent, passes somewhat further out and traverses the great trochanter.

Moreover, the two kinds of injury may be complicated together, the same fracture being partly within and partly without the capsule; and again, there may be one fracture within the capsule, and a different one external to it, running through the trochanters.

The diagnosis of these fractures has for a long time engaged much of the attention of surgeons; but the fracture within the capsule has been the chief subject of investigation, with reference to the question of its reuniting by means of bony callus.

So rarely is this fracture reunited by bone, that many have doubted the fact; and on this account, as well as from the frequency of the accident, it is important to be acquainted with the changes which, in different cases, take place in the fragments.

It is often observed, in very decrepit persons, that even after a long period no trace of inflammation and exudation is discoverable upon the fractured surfaces. The capsule is slightly reddened and swollen; but the only change in the surfaces of the fragments is, that they are smoothed off in a marked degree by absorption. There are some cases in which, though the fragments present no mark of reaction, they are absorbed to such an extent, that the head of the femur forms a flattened, or concavo-convex disc, and its neck has almost entirely disappeared.

Sometimes partial necrosis takes place in the fragments, and the subsequent reaction degenerates into suppurative inflammation of the bone and articular capsule, and caries within the joint.

Usually the fragments, thus diminished more or less in size by absorption, are covered with a fibroid (ligamentous) tissue.

This covering is, in fact, callus, arrested in the progress of its development to bone, but in which now and then a few isolated splinters, or needle-like growths of new bone, do form. The fibroid tissue occasionally serves to bind the fragments closely together; but more commonly it is drawn out into ligamentous cords, which are inserted into the margins of the fractured surfaces, and compose altogether a tolerably complete capsule: such a capsule connects the fragments but loosely together, and their surfaces are moveable over one another. Or, again, there may be no ligamentous bands formed, and the surfaces of the fragments, unconnected with one another, but covered with the fibroid exudation, may articulate together within the old capsule. The false joint resulting has a freedom of motion proportioned to the quantity of the fragments which has been removed by absorption.

The rubbing of the surfaces against one another gradually wears down their fibroid covering of callus; it gradually, also, renders them smooth, and produces an ivory-like condensation of their spongy tissue. Hence, when the covering is entirely removed, two bare, smooth surfaces of bone, glistening and polished like ivory, are left to articulate together.

The false joint thus produced varies in its form. Sometimes two tolerably flat and even surfaces are applied to one another; at other times, one of the fractured surfaces is slightly hollowed out into an articular cavity, and the other forms an articular head. Accordingly, at one time the stump of the neck is rounded off, and fits into the fractured surface next the head, which has been a little excavated; while at another time, after absorption of the neck, the head of the bone moves in a large and slightly concave articular surface, hollowed out between the two trochanters. It is worthy of remark, that in the latter case the line of the insertion of the capsule recedes to an extent corresponding with the absorption of the neck, and that the size of the articulation is thereby increased.

In a specimen of fracture of the neck of the femur, in the Museum at Vienna, a fragment of the head of the bone having fallen upon the fractured surface of the neck, and become bound to it by ligamentous tissue, articulates by its external and still cartilaginous surface, with the fractured surface of the rest of the head.

The fragments are, in some cases, uneven and serrated, and become wedged into each other at the time of the occurrence of the fracture; their surfaces then unite together by fibroid callus.

In a more frequent instance of this kind of accident, the neck of the bone becomes implanted in the spongy tissue of the great trochanter.

While these changes are going on in the fragments of the bone, the capsule of the joint becomes swollen, and its contents more or less turbid: it also frequently forms adhesions of a cellular or ligamentous nature, with the fibrous investment of the neck of the bone, as well as with the fibroid callus upon the fractured surfaces.

In some extremely rare instances the fragments do unite within the capsule by means of bone; it is a mode of union which is almost always very slowly accomplished, and in which there is considerable shortening of the neck of the bone. That fracture, too, in which the neck of the bone is driven into the spongy tissue of the trochanter has been seen repaired by bony callus.

The rarity of union of intra-capsular fracture of the neck of the femur by bone, when the accident is so frequent, has for a long time elicited much research into the reasons why the customary mode of repair does not take place in this instance. Many reasons have been assigned for it, but it must be acknowledged that none of them is satisfactory. Amongst them are the following:

a. In general, the advanced age of the persons in whom the accident occurs; and, in particular, a state of atrophy of the skeleton.

β. Insufficient nutrition of the separated head of the bone, by the few vessels that enter it through the ligamentum teres.

γ. The presence of synovia and other effusions between the fractured surfaces.

δ. The difficulty of securing and maintaining proper adaptation of the fragments to each other, and the want of some permanent pressure to effect it: and, lastly,

ε. Want of rest.

No one of these reasons, as has been stated, sufficiently explains the matter. That no reaction takes place in the fractured neck of the femur in an aged and decrepit person is intelligible, because the same fact is very often observed in

such persons in fractures elsewhere : but this does not explain why the formation of callus should be so backward generally, even under less unfavorable circumstances, and why the proper changes in it should be so commonly frustrated. This consideration derives additional importance from the fact, that in the majority of cases, and even as a rule, no bony union takes place in fractures of any bony structures which are enclosed within an articular capsule.

On more closely examining the subject, the principal conditions appear to be two : the first is, that no primary or provisional callus whatever is formed ; and the second is, that the secondary or definitive callus is arrested in its development at the stage of fibroid (ligamentous) tissue. It is the want of the first callus that, for the most part at least, arrests the growth of the later callus, and commonly leads to the formation of a false joint. The only object now, therefore, is to determine the reasons why no provisional callus is thrown out.

The following circumstances appear to me to be the chief impediments :

1. The small amount of vascularity possessed by that portion of the fibrous capsule of the joint, which occupies the place of periosteum ; to which, as well as to the density of its structure, and, more especially, to its close adhesion to the bone, it must be attributed, that no exudation, preliminary to the formation of the provisional callus, takes place between the bone and its fibrous investment.

2. But the principal cause is the small share which the soft parts take in the reactionary process : they are placed at some distance from the seat of fracture ; and the distance is further increased by distension of the capsule with exudation : in addition to this it happens that the exudation, whether in consequence of its being diluted with synovial fluid, or from its original quality, almost never becomes organized to bone.

It is, therefore, the want of the first callus and of that firm fixing of the fragments which should be effected by it, that really prevents any union of the fragments by bone, that interferes with the production of the secondary callus, and leads to the formation of a false joint ; and the influence of this deficiency is, in ordinary cases, greater in proportion as the difficulties enumerated under the heads δ and ϵ are brought into action.

However constant the failure in the production of callus at the seat of fracture itself, yet now and then the growth in question does occur in other places, when an energetic reactionary process springs up around. Thus, sometimes shallow cup-like masses of callus are developed on the enlarged capsule of the joint; in other cases, especially those in which the neck of the femur is driven into the substance of the trochanter, callus is poured out upon and around that process; and in some other rare cases the head of the bone unites with the acetabulum by a deposit of callus, which produces atrophy of the cartilage covering the bones, and takes its place.

Fracture external to the capsule is generally repaired by bony union, but sometimes a false joint is formed. Even in the former case, the union is attended with some deformity, either displacement of the fragments and shortening of the extremity, or shortening, and a more horizontal position than natural of the neck of the femur. Sometimes, too, the neck is driven into the spongy tissue of the upper end of the femur.

Fractures of the neck of the femur, as I have already mentioned, are of frequent occurrence. Their principal predisposing causes are advanced age and senile atrophy of the bones. To these may be added, the depression and more nearly horizontal direction, which is peculiar to the neck of the femur in old age; and as that position of the neck is the normal condition in the female, it is supposed to account for the greater frequency of the accident in the female sex. The external cause is usually a fall upon the trochanter, or a fall vertically upon the feet and knees.

Transverse fracture of the patella requires notice, because of the considerable displacement which attends the repair of the injury. The capsule of the knee joint is enlarged upward on the femur to a corresponding degree.

§ 5. *Diseases of Texture.*—Like hyperostosis, these diseases have been sufficiently described in the Chapter on Diseases of the Bones in general.

PART X.

ANOMALIES AND DISEASES OF CARTILAGES.

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ANOMALIES AND DISEASES OF CARTILAGES.

CARTILAGES are naturally divided into the true and the fibrous, and accordingly the morbid affections of each kind require to be separately noticed.

§ 1. *Deficiency and Excess of Development.*—An absolute primordial deficiency of these structures is seen only in concurrence with the entire absence or partial development of organs, into the composition of which they enter.

So, too, an original excess of their development is very rarely met with, unless those parts, of which they form the groundwork, be more or less completely double. Now and then, however, some small supernumerary pieces of cartilage are observed on the external ear, the nose, and the larynx, and especially at the inlet of the last-mentioned part.

But during extra-uterine life, the production of cartilage is a less unusual occurrence. It approximates in the character of its texture sometimes to true cartilage, and sometimes to fibro-cartilage. Many of the false joints formed in cases of ununited fracture present instances of this growth in the white substance which invests the broken ends of the bone: cartilage is developed in many of the tendons, and in that situation it usually ossifies: the enchondroma, which is met with in the bones and different soft parts, affords another example of the same kind, &c. It is, however, necessary to remark, that many productions which have been hitherto reputed cartilaginous, or fibro-cartilaginous, are discovered by closer examination not to belong to either class: such, for instance, as the majority of the so-called loose cartilages in serous and synovial cavities, the cartilage found in encysted tumours, and in the parenchyma of organs, as the uterus or

thyroid gland, and what are called cartilaginous transformations of serous membranes and of the inner coat of the vessels.

§ 2. *Deviations in Size.*—There appears to be no genuine hypertrophy of cartilages. Not unfrequently, indeed, they are found irregularly swollen in joints, in which fibroid growths hang from the synovial membrane, in which the articular ends of the bones are deformed by gout, &c.; but this is a consequence of disease of their texture, especially of their intercellular substance. The same diseased condition precedes their wearing down or atrophy, which is often found considerably advanced at the same time that this apparent hypertrophy exists elsewhere. Atrophy, like hypertrophy of the cartilages of joints, occurs only when there has been some previous disease of their texture: it chiefly affects the large articulations, selecting especially the hip and knee. The loss of substance goes on gradually, and quite independently of contact with purulent matter in the joint.

On opening such a joint one or more spots of various size are found, at which some of the substance of the cartilage is lost. The margins of the defective spots are irregular, sinuous, and indented: the depth to which they reach varies, but they very commonly extend through the whole thickness of the cartilage. If any of it still remain, it is of a dull white colour, and has lost its glistening and homogeneous appearance; it seems to have assumed a filamentous velvety texture, and is at the same time softer than natural, moist, and succulent. Not unfrequently it is covered over with a cellulo-gelatinous vascular substance. When the cartilage has been removed in its whole thickness, there is some variety in the state of the surface of the bone: it is sometimes, and no doubt always when first denuded, invested with a delicate cellulo-gelatinous organized substance, which fills up the aperture in the cartilage; at other times, especially at a later stage, it is covered with a white fibroid tissue, into which the organized substance just mentioned has been converted; in a third case, it may be literally laid bare, and it then has a smooth appearance, as if it had been polished; it is whiter than the adjoining part of the bone, and denser, as well as whiter than natural, to some depth from the surface.

The cartilages are very frequently found thus changed in some one part of a joint, when no alteration is perceptible in the texture of the other articular structures, or in the character of the synovial fluid. But when the cartilage is lost at several places, and the defective spots are more extensive and coalesce, various anomalies are noticed in the other articular structures,—anomalies which are compounded of those already depicted, at pp. 173 and 200, as consecutive induration of the articular extremities of the bones, and a derangement of the joint, which is probably of gouty nature.

Attention has recently been attracted to this disease of articular cartilages, by the interest which the subject of diseases of joints has excited, especially in England, and more particularly with reference to their etiology and nosological import. In my own opinion, which is founded upon repeated investigations, the wasting of the cartilages is occasioned by some previous disorder in the cancellous structure of the articular ends of the bones, especially by their more or less intense inflammatory rarefaction, and consequent condensation. The first derangement of the texture of the cartilage is produced by the exudation effused into it from the adjoining bone. As the secondary process of induration goes on, the nutrient vascular apparatus of the spongy extremity of the bone becomes atrophied; and the further the induration advances, the more certain is the wasting of the previously diseased cartilage, for the extent and the degree of its atrophy correspond with the extent and intensity of the induration. The idea that this loss of substance arises from a true ulcerative destruction is altogether erroneous; neither at the spot itself, nor in the healthy condition of all the other articular structures, is there anything to countenance it.

In advanced cases, the cartilages may be entirely absorbed, or reduced to a few thin remnants, which are commonly situated at the borders of the articular surfaces. The opposite bones are thus brought into contact, and the ivory-like polish of their surfaces makes up, in some measure, for the loss of the cartilages. The disease is commonly known in Germany as the eburnated condition of joint, the name which was given to it by Lobstein. In its higher degrees it is associated with other anomalies, which have already been mentioned as occurring in

the articulations, and which have yet to be collected and arranged together in the article on Diseases of Joints. It must be distinguished from other cases in which a similar, but much less marked, ivory condensation and polish of the articular surfaces of the bones, succeeds to the destruction of the articular cartilages by ulceration, and in which, accordingly, the change in the spongy tissue of the bone is not the primary affection, but is due to the loss of the cartilage.

Atrophy of cartilage, and the change in the cancellous structure, which gives rise to it, are most frequently met with in advanced life. It is a remarkable fact, to which attention was first directed by Gulliver, that the disease is apt to occur symmetrically in corresponding joints.

The fibro-cartilages, which are most subject to atrophy, are those of the spine. They are found wasted in curvatures of the column, especially in considerable lateral curvatures; and so much of them may be absorbed in the concavities of the curves, that the bodies of the vertebræ come into immediate contact, and unite together. But, under other circumstances, they display a power of resistance, which surpasses that of the bones; and it is remarkable how little they yield to the pressure of aneurismal tumours. Moreover, in old age the intervertebral discs are subject to a form of atrophy, in which, first, the soft cartilaginous substance that enters into their composition is absorbed, and, at a later period, their fibrous texture: they become dry and friable, their central gelatinous portion becomes fibrous, and partly disappears, leaving a cavity, which, as well as the peripheral parts of the disc, is filled with fat: the whole structure takes on a dirty yellowish, or rusty-brown appearance, the fibres losing their lustre, and becoming dull.

§ 3. *Solutions of Continuity.*—Lacerations of cartilages never occur without great external violence, and they rarely happen alone; either fractures of bone or lacerated wounds of soft parts being combined with them. Fractures of the costal cartilages are the most frequent; and either some ribs are broken at the same time, or the thoracic viscera are ruptured. Lacerations are met with also at the synchondroses of the spine and pelvis; and incomplete separations occasionally take place at some of the pelvic joints during difficult parturition.

These injuries are repaired in various ways. The uniting medium is never found to be new cartilaginous tissue. For the repair of injuries to true cartilages, the inflamed perichondrium supplies an areolar substance, somewhat like ligament, or else a bony callus. The tendency to reunite in the latter way seems to be regulated by the proneness of the cartilage to ossification when in its natural state. Thus fractures of the costal cartilages generally unite by means of a cup-, or ring-shaped bony callus, which encloses the fractured part in a sort of capsule. Injuries to the fibro-cartilages heal like wounds of cellular tissue and tendons.

§ 4. *Diseases of Texture.*—The principal disease to which cartilage is liable is,—

1. *Inflammation*, a subject of much discussion, on which its anatomical characters and experiment have been alike brought to bear.

From our present knowledge of the texture of cartilage, as well as from direct observation, we are compelled to deny, that true cartilage, while its texture is normal, ever inflames; but we know by experience that, without being the immediate seat of an inflammatory process, such a cartilage may suffer very serious, and sometimes very rapid, lesions of its texture, from the effect produced on it by inflammation of adjoining tissues, and by the products of that inflammation, and even from imperceptible anomalies in the composition of the synovial fluid. No doubt it is this sensitiveness of cartilaginous tissue to the influence of neighbouring inflammation, and inflammatory products, which has led to the presumption, that cartilage does itself inflame; and such a presumption would seem confirmed, if the adjoining inflammation were regarded as secondary to that of the cartilage. The structures which inflame in such close contact and relation with cartilages, and on which the changes in the cartilages now under consideration may in some measure be studied, are the synovial membranes of large joints, the articular ends of bones, and perichondrium. The last-mentioned structure may be the seat of a primary inflammation, or may become involved in inflammation or ulceration going on in other tissues, such as mucous and serous membranes, muscles, &c. The vascularity which Mayo and Liston

have together in the same manner their substance, and to which I have also referred in § 1. 2. 3. A whitish streak a subordinate substance, forming as when the texture of the cartilage is actually changed. This is a secondary condition, it may at times remove the seat of inflammation, and a free intercellular substance may be found beneath on the surface of parts in which inflammation is going on.

In cases of slight inflammation of synovial membrane, and even in those in which there has been it from the joint having been injured for some time, the synovial fluid has diminished in quantity and at the same time intensely undergoes some change in its constituent elements. The articular cartilages lose the lustre of their surface, without becoming reddened, or perceptibly inflamed. As they continue longer in contact with the exudation they assume a yellow colour, and a lower and softer texture than natural, so that they look like short-napped felt. On minute examination, the intercellular substance is found at first to be rendered opaque by the presence of a number of fine yells and indistinct filaments: afterwards the Stromatous arrangement becomes more distinct, and is found to be perforated sometimes by foci of wavy cellular tissue, and flat-tubes filled, which are degenerating and assuming a similar character,—both which, as well as the rest of the intercellular substance, swell, and become transparent, when treated with alcohol, and,—and sometimes by delicate uncoloured fibres spread out into a membrane. The cells are round, as if distended, and project from the fibred blastema; in many of them the nucleus is indistinct, and breaks into small rounded points, or degenerates into a fat globule: in the latter case there is a great deal of free fat in the blastema, and the cells are filled with small shining molecules of fat. When in this state, just as in atrophy, the cartilage is gradually worn down and lost.

When the cavity of a joint is filled with purulent exudation from the synovial membrane, the most superficial layer of the cartilages, being in contact with the matter, loses its glistening and translucent character, and becomes of a dirty, yellowish colour; but as it gradually changes into a gelatinous substance, it becomes transparent, though it still remains discoloured. The proper texture of this layer is completely destroyed, and

it degenerates into a finely granular mass. The changes already described go on in the subjacent layer; that is to say, the intercellular substance assumes a fibrous character, and fat is developed in remarkable abundance. When the costal cartilages suppurate in this manner, groups and bundles of peculiar, stiff, straight fibres are sometimes formed in the intercellular substance.

These changes are sometimes found occupying the whole surface of the articular cartilages uniformly, but more commonly they are confined to certain spots of various sizes.

If the articular ends of the bones be acutely inflamed, some of the product of the inflammation which is effused upon their surface loosens the cartilage from them; and in that case the change above described takes place in the cartilage, so soon as the inflammation has extended to the synovial membrane, if it have not done so already.

The same changes in cartilage ensue when its perichondrium is inflamed, and the purulent matter is effused on the inner surface of that membrane: of this we have an instance in inflammation of the investing membrane of the cartilages of the larynx. They suffer in the same manner if the perichondrium be destroyed by ulceration advancing from other organs; as is the case in the cartilages of the larynx when situated at the base of degenerated typhous, or tubercular ulcers; or in the cartilages of the ribs, when there is any tuberculous ulceration of the costal pleura.

It is an old and interesting observation, that ossification is apt to be induced in cartilages by the occurrence of inflammation in their vicinity; but it takes place only in those cartilages which by their physiological constitution are wont to ossify, such as the cartilages of the ribs and larynx.

Inflammation, though rarely met with in the fibro-cartilages, does unquestionably occur in them; but the changes it produces in them differ somewhat from those just described. It is remarkable for its acute course, and for the rapid ulcerative destruction of the fibro-cartilage to which it leads: its anatomical characters are much the same as those of inflammation of fibrous organs. An inflammation is sometimes met with in the inter-vertebral cartilages, which terminates sooner or later in suppuration, and is generally in the end combined with inflam-

mation and caries of the bodies of the vertebræ, inflammation of the spinal membranes, &c.

After difficult parturition, the synchondroses of the pelvis, and especially the fibro-cartilage of the symphysis pubis, are subject to an inflammation of low type, which owes its origin to putrefactive (septic) phlebitis, and rapidly destroys the fibro-cartilage in a similar manner to the worst forms of putrefaction. (Compare p. 56.) The cartilage is found inclosed in a capsule formed of the adjoining ligamentous apparatus, but it is changed into a diffuent, fetid pulp, resembling chocolate or coffee-grounds, or into a fluid sanies. Sometimes the disorganized mass is found in an irregular cavity, having insinuated itself to various distances beneath the periosteum of the neighbouring bone.

In the cartilages which Miescher has named the yellow cartilages, and which have a general connection with those now under consideration, an inflammation occurs, which is mostly chronic in its course, and which, after loosening and swelling the texture of the cartilage, usually terminates in atrophy and fibroid induration of it, and consequently in deformities of various kinds. Hence the epiglottis, and more frequently some of these structures about the tarsus, are found puckered, bent, tilted upward or downward, &c.

2. *Ossification of cartilage.*—Some of the true cartilages are, under various circumstances, subject to real ossification, to conversion into genuine bone. The thyroid and cricoid cartilages ossify in this manner in men at about forty years of age; and ossification of the costal cartilages is so frequently observed in old persons, that it can only be looked upon as a pathological appearance when it is found at an earlier period of life. The cartilages of the larynx ossify from different points: those of the ribs change to a dirty yellow colour in old age, become saturated with fat, and then ossify in the middle, the central vascular canal enlarging so as to form a medullary cavity. The ossification of those laryngeal cartilages which I have mentioned, is often excited and advanced by inflammations which extend to the perichondrium from without, especially the inflammation which occurs at the base of tubercular ulcers and in the neighbourhood of softening tubercle. Hence it sometimes happens that tracheal phthisis

is after a time complicated with caries of the newly-formed bone.

True ossification of a fibro-cartilage is in every case highly problematical. The ankylosis of synchondroses which appears to result from such a change in the fibro-cartilage, is probably never produced by conversion of that structure into bone. Either new bone, in the form of an osteophyte, passes between the margins of the adjacent surfaces of the ankylosed bones, inclosing the fibro-cartilage in a sort of capsule; or the two bones are united together in the whole extent of their adjoining surfaces: in the latter case, there can be no doubt that the new osseous matter is formed on the surfaces of the old bone, while the fibro-cartilage is absorbed. In this class of cases are included those rare ones of complete ankylosis of the synchondroses of the pelvis and of the vertebral bodies: and allied to it is another kind in which the vertebræ are fused together on the concavity of lateral curvatures in consequence of the absorption and displacement of the intervening cartilages by pressure.

On the other hand, several of the so-called yellow cartilages are, in very rare cases, the seat of a bony concretion, which is formed in some fibroid callus left in them after chronic inflammation. The epiglottis is an instance of this.

3. *Adventitious growths.*—These growths appear not to occur in the cartilaginous system, and certainly they do not in true cartilage. Its structure will resist the progress of advancing cancer for a long time, and even altogether. The costal cartilages do indeed disappear in the degeneration of large mammary cancers, and the arytaenoid cartilages form a very remarkable exception to the rule; for from what I have hitherto been able to ascertain, it appears as if the cancerous growths, or those suspected to be cancerous, which project into the larynx, very commonly spring from those cartilages. Tuberculous and cancerous degenerations affect the cartilages in the manner already described under the head of Inflammation.

APPENDIX.

ANOMALIES AND DISEASES OF JOINTS.

OF all deviations from the healthy condition of Joints, the diseases of texture are the most serious, both on account of their frequency, of their relations to other diseases, and of the varieties which they present in their earlier stages, according to the particular structure that was affected first, among the many of which the compound apparatus of joints is composed. Moreover, they very often lead to alterations in the relative position of the bones, and in the form of the joints.

§ 1. *Deficiency and Excess of Development.*—Just as, when one or more bones are wanting, there is a deficiency of the corresponding joints, so in the opposite case, supernumerary bones are articulated to the skeleton by additional joints. But sometimes joints are really absent; or, when the bones which should compose them are incompletely developed, a mere indication only of the articular structures exists. The osseous framework is partially developed and rudimentary; the capsule of the joint is very small; and when the bones fail much of their complete development, though the stump which represents their articular extremity be covered with cartilage, the capsule is detached, and the ligaments are partly or altogether wanting. The joints by which supernumerary bones are attached are very commonly defective; and in congenital ankylosis the articular apparatus is entirely absent.

On the contrary, supernumerary joints are met with, not only when there are more bones than usual, but when their number is natural. Not an unfrequent example of the latter fact is shown in the connection of adjoining ribs together by means of an articulation.

§ 2. *Deviations of Form.*—These deviations are extremely numerous and very varied in their character: sometimes they

are congenital, and are caused by some fault of original formation; at other times, and far more frequently, they are secondary, and occur either before or after birth, as consequences of permanent dislocation of the bony structures of the joints, or of disease of their texture.

The cases of the former, or congenital, class may in general be reduced to unnaturally large or small size of the heads, or prominences in joints, on the one hand, and to increased or diminished capacity of the fossæ on the other. And the shape of articulations may be altered in various ways by the shortness or unnatural position of articular processes, or by peculiarities in their attachment to the shaft of the bone; a fact of which the import has been shown in the instance of the neck of the femur.

The deformities of joints which are acquired after birth, are much more numerous and more important: they consist, in general, of some uneven enlargement, flattening, or diminution, or of complete destruction of the head of an articulation; of dilatation, narrowing, or wasting of articular cavities; of bending of bones, and their articular processes, &c.

§ 3. *Alterations in the Contiguity of the Structures of Joints.*
—The chief of these anomalies are dislocation and ankylosis.

Dislocation consists in the slipping of the portions of bones which compose a joint over one another, so that they enter into new relations of contiguity. It is evident that there may be many degrees of it; and hence a distinction is drawn between complete luxation and incomplete, according as the articular surfaces are entirely separated, or still remain in some contact with each other.

There is a difference, too, between luxation from violence and spontaneous luxation, which occurs in the course, and is a consequence, of inflammation and ulcerative destruction of joints, but yet, as will appear, is a consecutive, and not an essential, phenomenon of the disease. The former is a result of violent injury to a joint, or of transient or persisting immoderate muscular action, and it occurs most frequently in joints which have freedom of motion. The greater the displacement, so much the more is it complicated with stretching, or rupture of the ligaments of the joint, and even with laceration of muscles,

vessels, &c. Rupture of the ligaments most commonly occurs in the dislocation of joints which have limited motion. Unnatural width or shallowness of the cavities of joints, and too great length and laxity of their ligaments, predispose of course to dislocation, and to the occurrence of it upon slight occasions. The facility with which dislocation occurs in some individuals, and their ability to produce it at will (habitual dislocation), depend upon the same physical condition.

Spontaneous luxation is usually the result of destruction of the bony parts of a joint, and of the retraction of the surrounding muscles which takes place in the course of the disease: the extent of displacement corresponds with the amount of destruction which has occurred. A further account of this condition will be more conveniently given below.

Lastly, luxation may be either congenital or acquired. Congenital luxation has been only lately recognised: it has been observed in several joints, chiefly in the hip. Guérin regards it as probably the consequence of muscular retraction in the fœtus, just like club-foot, which is essentially a dislocation. Various other dislocations may, like club-foot, be produced at later periods of life by muscular retraction. Congenital luxation, when examined in a grown-up person, does not present such striking characters that it can be distinguished with certainty from a dislocation which occurred in early childhood, or even from one produced by muscular action before the bones were completely formed. It appears to me to require a thorough examination of the patient in order to determine any particular luxation to have been congenital; for, in the hip-joint more particularly, the changes which are produced by coxalgia bear a deceptive resemblance to congenital luxation, and many cases of that disease have, in the preparation, been looked upon as congenital dislocation.

Luxation is followed by some more remote changes in the joint. The capsule becomes enlarged, and the place of its insertion altered; the articular cavities of the bones increase in size, and undergo various changes in form; and corresponding alterations are produced in the articular heads or prominences. In other cases, in which the dislocation is complete, the capsule wastes, and the bony cavities diminish in size, or are filled with masses of new osseous substance; the

displaced head of the bone loses its character, and a new joint is formed. The cellular structures which surround the dislocated head inflame, and frame a new capsule around it, which, for the most part, fits closely, is of fibroid structure, and has a serous lining; whilst the pressure of the head in its new position occasions a shallow articular excavation beneath it. In other cases, instead of an excavation beneath the head, a mass of callus springs up around it, and forms either a hollow to receive it, or a level surface, which the head may be flattened in order to fit; or, lastly, the callus may project, and that which was the articular head be excavated to receive it. Sometimes the quantity of new bone deposited around a dislocated head is very abundant, and retains it firmly in its place.

In dislocations of long standing, the pressure upon the vessels and nerves interferes with the nutrition of the luxated bone, and, like the soft parts, it is found in a state of atrophy.

Of *anchylosis* (stiffness of a joint) there are many degrees. In the highest the joint is fixed by means of bone,—two bones which were connected by articulation, unite into one—*synostosis*. In slighter degrees the synovial membrane wastes, the cavity of the joint is obliterated, the articular extremities of the bones become bound together by means of a fibroid or cellular tissue, and the joint is still capable of some motion. These constitute true *anchylosis*, and must be distinguished from the stiffness of a joint which is produced by swelling, shrinking, and tightness of the fibrous ligaments, or of the fasciæ which surround a joint, or that which arises from a contracted state of the muscles, &c. To such the name of false *anchylosis* is commonly applied.

Anchylosis is, in most cases, the consequence of well-marked inflammation of a joint, and frequently occurs, therefore, after injuries in its neighbourhood, or when caries or necrosis encroaches upon it. But it comes on also without causes of this kind in joints which have long been unused; especially in contracted joints, the articular surfaces of which have remained for a long time in close contact with one another; and in old age, in which the diminished secretion of synovia probably gives the first occasion to structural disease, and ulceration of the cartilages of the joint.

In bony ankylosis the articular ends are either bound together by flattened or rounded bridge-like growths of bone which frequently follow the course of the fibrous ligaments; or they are so united in their whole thickness, that the two or more bones which composed the joint now form but one. Sometimes, on making a section of an ankylosed joint, in which there has been no previous loss of substance in the bone, a streak is seen which represents the compact articular surface; but if that have been destroyed by suppuration, the spongy substance of one bone is uninterruptedly continuous with that of the other.

Ankylosis is sometimes confined to a single joint, sometimes it exists in several: a few cases have been observed in which nearly all the joints were ankylosed, and most of the synchondroses also.

The joints in which ankylosis most frequently occurs are the hip, the elbow, and the knee; next in order to them are the joints of the foot and hand, then the shoulder, and the articulation of the atlas and occiput, whilst that of the lower-jaw, and the sterno-clavicular, and acromial joints are very rarely affected.

§ 4. *Solutions of Continuity.*—To this class belong fractures of bone within the capsule of a joint, lacerations of the capsule and ligaments, disruption of the interarticular cartilages, of the cartilaginous coverings of a joint, &c., and all of them are results of violence.

§ 5. *Diseases of Texture in Joints.*—These diseases commence either in the fibro-serous capsules, or in the bones, and scarcely ever in the cartilaginous coverings of the ends of the bones or in the interarticular cartilages. In the course of disease, however, all the different textures composing the joint are affected, and in different ways: this remark applies especially to inflammation, which is by far the most frequent disease of joints. In treating of it, therefore, as well as of the other diseases of texture to which reference must be made, I shall observe that distinction in a manner as closely accordant with nature as possible.

1. *Inflammations.*

a. Inflammation of the synovial membranes of joints.—In the consideration of this, as well as of the other diseases of synovial membranes, frequent reference must be made to the statements contained in the chapter on the Diseases of Serous Membranes in general. (p. 17.)

Inflammation of a synovial capsule is sometimes a primary disease, and occasioned either by various injuries, such as fracture within or near the capsule, dislocation, &c., or by atmospheric influences; in the latter case it is named rheumatic: sometimes it is secondary, and results from metastasis. It is also very frequently brought on by the inflammation of an adjoining tissue, as of the bones, or their articular extremities, or by caries, necrosis, &c., in the neighbourhood of the joint.

Secondary inflammations—those which are the result of metastasis—occur chiefly in the larger joints, and especially in the knee.

Moreover, the inflammation may have an acute course, or may be chronic. In either case, it may produce any of the different exudations mentioned in the chapter that has been cited, and may have in general the same terminations. The best marked inflammations in the structure under consideration are those which furnish a purulent or a hemorrhagic exudation, and those the product of which becomes converted into tubercle. When the amount of exudation, and the consequent enlargement of the synovial membrane are considerable, and when the disease involves on the one hand, the cellular, muscular, and fibrous soft parts, and the ends of the bones on the other, the whole disease constitutes that affection which, from certain stages of its progress or from some one prominent character, is commonly called white swelling (*fungus articulorum*, spontaneous luxation, *Arthrocece*). A case of this kind is most marked when the inflammation produces a purulent exudation, and terminates in suppurative destruction of the tissues of the joint, and when the exudation is tuberculous. Commencing originally in the synovial membrane or in the articular ends of the bones, this affection generally, when it is far advanced, involves such various textures, and produces such degeneration and destruction of them, that it costs some trouble to determine its original seat. And it is further important to remark, that whilst it is not altogether uncommon for it to

commence in the articular ends of the bones, yet the synovial membrane is far more commonly the organ first diseased. The inflammation of that membrane very often occurs in several joints at the same time; and with chronic inflammations of the larger synovial membranes, there frequently coexist inflammations of the same character, so far as the products are concerned, in large serous sacs, such as the pleura, the pericardium, &c.

A second, and yet more important observation is, that no exudation is deposited on that portion of the synovial membrane which covers the cartilages; if any of it should adhere to that portion of the membrane, it is in no case, whatever form it assume, to be regarded as a primary peripheral plastic effusion, but as a secondary precipitate, or deposition out of the general exudation in the articular cavity; and the opacity of the cartilages and of the layer of synovial membrane covering them is the result of imbibition.

Slight acute inflammations produce rather a turbid exudation, which is for the most part serous, and is easily reabsorbed. They terminate in resolution.

If the product of the inflammation consist of an effusion of serum and of a larger quantity of plastic material, the synovial membrane loses its glistening aspect, becomes opaque and more or less swollen, and is covered on its inner surface with a peripheral plastic effusion, which varies in thickness, and in the character of its free surface. Sometimes it constitutes a thin layer, sometimes a thick one, of uniform or of unequal depth: and as in the latter case there are some extensive spots on which it is scarcely perceptible, and other smaller ones, on the contrary, at which it is accumulated, it forms islands or 'plaques' of various, and sometimes very considerable thickness, or even nodulated masses. When it is of trifling thickness, its free surface usually appears fine and villous, but when its thickness is considerable, the surface is shreddy. Very frequently also there is found cleaving to the surface more or less of a soft precipitate out of the effusion, which can be easily removed.

As the whole process is usually chronic from the first, or becomes so in its course, the effusion which remains, and the enlargement of the capsule, render any adhesion and union

of the surfaces very rare ; and the plastic effusions are converted into a new tissue, composed of free or of coarse shreds, and of fibrous (fibroid, fibro-cellular) texture, which adheres to the synovial membrane.

Specimens are to be met with in nearly every collection, of large joints (especially knee-joints) in which the capsule is enlarged and thickened, and its inner surface covered with white shreds of various lengths, which are occasionally so numerous, that the joint seems as if it were lined with felt ; sometimes the shreds are simple, smooth, rounded, or rather flattened threads, or they here and there form a membranous patch upon the surface, or have their free extremities split into filaments and resembling a tassel. In extreme cases, small, smooth, and subovate bodies, which Mayo compares to melon-seeds, are attached to their extremities, hanging singly or in clusters from each stalk : and lastly, here and there amongst them shapeless masses are attached by broader bases. They all have a fibrous or fibroid texture, and are of innocent character, having nothing in common with the cystic and cancerous productions which are found on normal or anomalous serous membranes.

The cartilages of the joint and the bones remain, in many cases, uninjured throughout the process : and excepting a perceptible turbidity, nothing unnatural is found in the synovia. In other cases, on the contrary, the cartilaginous coverings of the articular ends of the bones become diseased. Such cases are commonly looked upon as rheumatic affections of the joint ; but chemical analyses of the original exudation, and of other secretions and excretions in the course of the disease, are required to establish their true nature. The cartilages become swollen, and thicker than natural, and usually uneven ; they acquire a marked opacity, and dull white appearance, and gradually assume a fibrous texture. If the disease do not materially interfere with the use of the joint, the cartilages, when thus changed in their texture, and the menisci, or inter-articular cartilages, are gradually worn away : and the exposed surfaces of the bones continually rubbing against one another, become dense and polished like ivory. The synovial membrane in such joints becomes still more turbid, of a dirty grayish colour, and even flocculent. The progress of the disease is

very slow, and frequently is quite unnoticed; indeed many observers have on that account been led to doubt its inflammatory nature.

In yet another class of cases the articular extremities of the bones are diseased; and they may be either primarily affected, or secondarily, by the advance of disease to them from the synovial membrane. I shall have occasion to describe these cases among the inflammations of the articular ends of the bones, as a change in joints probably dependent on gout.

Inflammations with a purulent, and those which have a sanious, exudation, are on several accounts serious; because they frequently terminate in suppuration (phthisis) of the various tissues of the joint; because of the extension of suppuration beyond them; because of the so-called spontaneous dislocations of the bones which ensue; and, lastly, because of the ankylosis in which they terminate in favorable cases.

The quantity of purulent fluid effused into the cavity of the joint is generally considerable, and the capsule is consequently much enlarged: the synovial membrane is lined with a firm, shreddy layer of lymph, which is dissolving into pus, and a softer purulent precipitate, which can be easily removed, adheres to the cartilages. The first-mentioned layer is opaque and lustreless, its surface is rough, and serum is infiltrated, and blood in small spots extravasated through its tissue, as well as through that of the fibrous capsule of the joint, and neighbouring cellular structures. As the disease advances, the infiltration and thickening of the neighbouring structures increase, they become filled with a gelatinous, lardaceous, white product, in the midst of which fibrous tissues, capsule, ligaments, or aponeuroses, can no longer be recognised. Here and there, in the mass, there are cavities of different dimensions, the lining of which is vascular, spongy, and granulating, and the contents purulent. The muscles near the joint are pale and flabby, infiltrated and attenuated. At length the infiltration reaches the subcutaneous cellular and adipose tissues, and the integuments become fixed to the disorganized structures beneath. The diseased joint then presents the following external appearance: it is swollen, and always more or less bent; it feels everywhere soft and flabby, or in some spots

flabby, in others firm, elastic, doughy, and, at the same time, tuberculated; the integuments over it are tense and pallid, —leucophlegmatic, or they are traversed by varicose veins. (White swelling. *Fungus articuli*.)

At length ulceration commences, and advances in various directions. Externally, the capsule ulcerates in one or more spots, and then the soft parts adjoining it. In some instances, large openings form in the capsule, and connect the joint with ulcerated cavities in the soft parts; in others, mere sinuses are formed: but in either case they open externally through the skin, and occasion and maintain a discharge of the contents of the joint. Internally, the interarticular cartilages and the ligaments ulcerate, the cartilage covering the bones, when brought into contact with the matter, is destroyed in the way that has been mentioned, and the ulcerative inflammation attacks even the bones, if they have not been involved already.

The cavity of the joint appears like a cloaca, surrounded with a gelatino-lardaceous mass: the integuments covering it are of a dark red hue, and are especially discoloured at the orifices of the sinuses. The joint contains pus or sanies of an offensive odour, and variously discoloured, the repeated hemorrhages which take place when there is acute caries of the bones, very frequently giving it a red or brown tinge: the ligaments ulcerate, and the cartilages separate, partly or entirely, from the bones: the osseous surfaces are laid bare, their compact wall is destroyed, and the spongy tissue is exposed, infiltrated with pus and ulcerating, and surrounded on all sides by osteophytes of various shapes: remains of the fibrous structures of the joint, pieces of loosened cartilage, and of necrosed bone, are mixed with the matter discharged from the joint. The soft parts, and the entire bones belonging to the diseased joint are wasted, most of the fat is absorbed, the muscles are remarkably blanched and thin, and the bones, being generally in a state of excentric atrophy, are soft and fragile.

More or less quickly after the disease has reached this stage, spontaneous dislocations, as they are called, ensue. In modern times doubt has been cast upon the fact of dislocation occurring in consequence of large effusion into a joint, but experience certainly proves that such dislocations

do take place. The head of the femur has, in some few cases, been forced out of the acetabulum by a large exudation into the hip-joint; and thus, the views of ancient authors on the subject of Coxarthrocace, though, in many respects, unquestionably defective, are justified, and the manifold criticisms to which they have been subjected, are corrected.

The great majority of these luxations occur in the last-described stage of an inflammation attended with purulent exudation, and are consequences of the destruction of the ligaments and articular ends of the bones; they are brought about by the continued action, and follow chiefly the direction, of the flexor muscles; though, if the bone be much destroyed towards any other part, the direction of the dislocation will be modified accordingly.

The most favorable case of repair of this disease, is discharge of the matter, and ankylosis of the joint. The cavity of the articulation is obliterated, being filled with a new growth of organized cellular tissue, and with an abundance of fat. The bones become knit together, either by means of an ossifying exudation, which is furnished by their compact articular surface, or, if caries have taken place, by the granulations which spring from their exposed spongy tissue: and the more closely the bones are in contact, the earlier is the union completed. The soft parts around, which have been inflamed, infiltrated and ulcerated, contract, assume a white fibroid texture, and cicatrize; and the whole joint appears wasted.

Inflammations, which furnish a hemorrhagic product, take place under the general and local conditions which are peculiar to them: they chiefly attack large joints, and especially the synovial membrane of the knee. They are usually associated with hemorrhagic effusions into large serous sacs.

In those inflammations, the product of which becomes converted into tubercle, the same conditions may be observed, which have been adduced as applying to inflammations of this kind in serous membranes in general: they constitute the usual, and almost the only, form in which tuberculosis occurs in synovial membranes. They lead to tubercular ulceration and destruction of the tissues of the joint, and are the cause of a great number of what are called "white swellings." I shall have to advert to this subject again.

b. Inflammation of the spongy articular extremities of bones.

—Inflammation, and the inflammatory osteoporoses or rarefactions, of bone having been already considered, there are only a few special remarks to be made in this place.

The articular ends of bones are frequently the seat of inflammation, especially in young persons; and the inflammation often passes into caries. Inflammation of the synovial membrane, of course, accompanies it, with equal readiness and frequency; and there is great difficulty in any particular case of inflammatory disease, especially in one of ulcerative destruction of a joint, to determine in which structure the disease originated.

As a general rule, that structure was the first diseased, in which the inflammation and destructive process are most advanced. If there be a considerable production of new osseous substance (osteophyte) around the articular ends of the bones, and on those portions of their articulating surface which have been divested of cartilage, if the ends of the bones be much enlarged, and their tissue expanded, if they be extensively carious, if matter be formed in their interior, but especially if the cartilage covering them be loosened, and the epiphyses separated, it is highly probable that the original disease was in the bones. The inflammation of the bones not unfrequently leads to an exudation which bears the characters of tubercular matter,—to a tubercular infiltration, in fact, of the spongy tissue of the bone: when this occurs, it is usually under the influence of a deep tuberculous taint of the system, which has, moreover, already exhibited itself by a tubercular deposition in some other part. Inflammation of the synovial membrane, attended with an exudation of tubercular matter, generally soon follows. (*Vide Tuberculosis of Joints, infra.*) The disease next in order is that form of—

Osteoporosis of the articular ends of bones, which I have, at page 173, distinguished as inflammatory; it ends in a particular kind of induration of the osseous tissue, and produces peculiar deformities of the bony apparatus of joints. An attempt to delineate it was made (p. 200) in the chapter on the characteristic features of Constitutional Affections of Bone, where it was represented as a change very probably dependent on gout.

The disease of the joint commences with loosening or expansion of the tissue of the bones, and enlargement of their articular ends, and it evidently is chiefly confined to the prominences, or articular heads. This softening and swelling of themselves occasion various deformities of the bony structures of the joint, and they are usually rendered still more striking by exuberant growths, which spring up simultaneously around the articulating surfaces. The most common deformity is that in which articular prominences become flattened, and their margin overhangs to such an extent, that their whole form resembles that of a mushroom: a corresponding widening and flattening take place in articular fossæ. But an articular prominence, especially the head of the femur, may be deformed in another way: it may maintain its shape, but still have an overhanging border: or it may be flattened from above only, and, at the same time, depressed; and may have a groove or impression at its upper circumference: in other cases it is elongated and conical; in others, again, uneven and tuberculated. Corresponding to each of these deformities of articular prominences, there is a deformity of the fossæ which they occupy. The expansion of the bony tissue (the osteoporosis) gradually passes into a white chalky condensation, or sclerosis.

The cartilages of the joint are gradually removed, and their removal is effected by several means. In the first place, their texture is probably altered by an exudation, which is poured out during the process of rarefaction upon the articulating surface of the bone. As the exudation thoroughly saturates the cartilages, their blastema assumes, as has been remarked, a fibrous structure, and they become of a dull white colour, and, at the same time, softer and more moist. This change of texture occurs the sooner if the disease in the bone be accompanied by inflammation of the synovial membrane, and effusion into the cavity of the joint. Whilst the cartilages are thus prepared for removal, the condensation of the bone, and the rubbing of the altered cartilages themselves against each other effect it. The one impedes or prevents their nutrition by the vascular apparatus of the spongy tissue of the bone, the other wears them down; and does so with a rapidity proportioned to the loss of elasticity

and of resisting power, which the change in their texture has occasioned.

When the cartilaginous coverings are removed, the continued attrition gives the condensed articular ends of the bones a polish like that of gypsum. At the same time, the interarticular cartilages, which have become useless from the deformity of the articulating surfaces, and have suffered more or less compression, are also worn down and removed. And in the hip-joint, the ligamentum teres always disappears, partly because it is wasted in consequence of the induration of the bone, and partly by being worn away.

The inflammatory process extends from the bones to the synovial membrane. The capsule is almost always thickened; internally it is frequently found of a rusty brown or slate-gray colour, and lined with a false membrane, that has a delicate villous surface, or with the fibroid growths before mentioned. The fluid in the joint is thin, turbid, and of a dirty grayish colour. Moreover, the capsule of the joint is dilated in proportion as the articular fossæ are enlarged; and its insertions extend beyond the normal bounds of the joint.

For other anomalies of the same kind, as well as for the enumeration of the joints most frequently affected with them, reference may be made to what has been said at other parts of this work; there is but one remark to be added here, which is, that the disease not unfrequently occurs symmetrically in corresponding joints.

2. *Adventitious growths.*

a. *Lipoma*.—This occurs in joints under the form which Johann Müller has distinguished by the name of *lipoma arborescens*,—a branching growth of fatty tissue in the free part, or in the duplicatures of synovial membranes: it occurs chiefly in the knee-joint.

b. *Fibroid tissue.*

a. When it occurs in connection with the synovial membrane, it is formed in old exudations; and it adheres to that membrane, assuming some of the manifold shapes already mentioned (p. 223.) In some of those forms it accumulates in great abundance. All the loose bodies (or mice, as they are called,) which are met with in joints, or at least a great part of them, belong to this class. (Comp. p. 41.) They are either

masses of exudation set free from the inner surface of the synovial membrane, or growths which have originated beneath it, or, lastly, formations (precipitates) from a synovial fluid of unnatural composition. In the last case, they are distinguished by their laminated structure.

β. Fibroid tissue occurs in the articular ends of the bones in the form of fibroid tumours, which sometimes attain very considerable size.

c. Tubercle.

α. Synovial membranes are the seat of tubercle; and, as has been casually remarked already, almost its only form is that in which it is a product of inflammation. It then usually co-exists with similar inflammations in large serous membranes, and as both are dependent on advanced tuberculosis of parenchymatous organs, especially of the lungs, it is associated also with a great degree of general tubercular disease. It affects chiefly the larger synovial sacs, such as those of the knee, hip, and elbow. When the exudation softens, and supuration takes place, the capsule of the joint ulcerates; and secondary tuberculosis, and tubercular ulceration of the bones ensue.

The articular ends of the bones are affected with tubercle, sometimes simultaneously with the synovial membrane, and sometimes before it.

β. When tubercle is formed in the articular ends of the bones, it is usually a consequence of inflammation, and is diffused through the spongy tissue of the bone. It gives rise to caries, *i. e.*, to tubercular abscesses, which very often break into the cavity of the joint (Nelaton). It is commonly very soon followed by inflammation of the synovial membrane, and tubercular exudation.

Both occasion the most terrible destruction of the tissues of the joint.

d. Cancers.

These diseases commence in the articular ends of the bones. The most frequent is medullary cancer, which, after reaching a considerable size, may advance into the cavity of the joint, but never commences, as a primary disease, within or upon the synovial membrane.

§ 6. *Anomalies in the Contents of Synovial Cavities.*—Most of these may be gathered from what has been said already ; and there needs only to mention here,—

a. Dropsy of the synovial membrane, which arises from the same causes as dropsy of serous sacs in general. In most cases it originates in a slight inflammatory process, the serous product of which contains very little plastic material.

b. The loose bodies,—articular mice,—which have been already described.

PART XI.
ANOMALIES AND DISEASES OF THE
MUSCULAR SYSTEM.

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§ 1. *Deficiency and Excess of Development.*—In very incompletely-formed monsters no muscles whatever, or merely a few traces of them, are to be found. Not unfrequently, when that portion is imperfectly developed, a few, or the whole, of the muscles of some portion of the body are wanting. This is the case with the thoracic and abdominal muscles, and those of the back, when the thorax, abdomen, or spine is fissured; or with the muscles of a limb, when the development of its skeleton is arrested; and some supernumerary limbs, which do not pass beyond a rudimentary state, never have muscles formed in them. A few rare instances occur in which most of the muscles of a limb are wanting, although its skeleton is perfect. And now and then a few unimportant muscles, or parts of muscles of the face, trunk, or limbs are missing, but the want of them does not interfere with the power of motion in the part.

Allied to these instances of deficient development, in which one or more muscles are entirely absent, there are others in which a muscle may be imperfectly developed in bulk (thickness and power,) and in texture. Sometimes one of its extremities is but partially formed, or not at all: or it may have no insertion, as is the case with muscles and their tendons at the stump of rudimentary limbs, or when, in the absence of the lower jaw, the muscles of the cheek are fused together with those of mastication. And, lastly, it may happen, that whilst the bony part of a limb is properly formed, the muscles are too short.

The form in which an excess of development presents itself is that of an increased number of muscles. Sometimes unusual ones exist, at other times a muscle has an irregular or accessory head, or an additional tendon; and, occasionally,

particular parts are stronger than usual, and are separated by unnaturally deep fissures into independent muscles. In the same class may be included cases in which muscles and their tendons exceed the natural length.

§ 2. *Deviations of Muscles from their natural condition in respect to Size or Volume, and Form.*—Some of the examples of originally faulty development which have been mentioned in the last section, belong to the present also; but there are other anomalies which, though sometimes congenital, more frequently occur after birth, and are, therefore, more properly arranged in this section: the anomalies in question are those of shortening, atrophy, and hypertrophy of muscle.

In *shortening* (*retractio, contractura*) the muscular fibres are permanently contracted: the cause of their contracting is excessive innervation, and the consequence is gradual wasting of the muscle. It leads to a proportionate deformity of the skeleton of the part, which becomes permanently straightened or bent, and has its articulations partially or completely dislocated, and the bones themselves curved and bent. Whether it be congenital or come on after birth, it is a result of repeated tonic cramp. It is seen in wry neck, in club-foot and hand, in several of the curvatures of the spine, &c.

The circumstances under which *atrophy* of muscles takes place are various; sometimes it is a simple wasting, at other times a complicated. The former kind is distinguished by the muscular structure being paler than natural and easily torn, and is general throughout the whole muscular system; it is a consequence of advanced age, and of various diseases, and is found with gelatinous softening of the stomach and intestines in children, in the phthises, especially tubercular phthisis, in cases of extensive cancerous growth and cancerous degeneration, and in consequence of slow poisoning, especially with lead. An atrophy of the same kind ensues, but is more partial in its extent, when particular groups of muscles have been insufficiently used, and in paralysis. In some muscles it is brought on by the gradual pressure and distension which they suffer from the enlargement of organs, the dilatation of cavities, or from morbid growths: as by an enlarged thyroid gland, dropsical distension of the cavity of the peritoneum, aneurisms, sarcoma, cancers, &c.

A complicated atrophy of muscle is that in which the texture of the fibre is changed. Contracted muscles waste in this manner: they lose their natural colour, and become first of a pale yellowish-red, then of a fawn, and lastly, of a dirty white colour; while at the same time they degenerate into a firm, tense, fibrous (fibroid) cord. Muscles which are absolutely unused, such as those of ankylosed joints, waste and degenerate into fat. Moreover, the muscles are generally found atrophied when much fat is formed in the body.

A remarkable form of atrophy has been described by Mayo, which in two cases that came under his care, was brought on by long-continued exposure to cold, was attended with much pain, and ran a very acute course. It is a subject on which further investigation is still required; and in order to direct the attention of medical men and pathologists to it, I introduce here the second of Mayo's two cases.

A labourer, *æt.* 45, who had been much exposed to wet, and was in the habit of allowing his clothes to dry upon him, was attacked, four months before he was seen, with pain in the left shoulder, which continued almost uninterruptedly for six weeks. It was most severe about fourteen days after it commenced, and still became sometimes so violent, that it seemed, he said, as if his arm would drop off. There was neither swelling nor redness; nor was there any numbness or tension when the shoulder was pressed, but he felt great pain when he raised the arm with the other hand. Without that assistance, he could not lift it at all. About a week after the affection had begun, he noticed that the shoulder was wasting. As the pain subsided, the wasting gradually advanced, and at the time when he was examined, the deltoid, supra-spinatus, infra-spinatus, and the two teres muscles appeared to be completely absorbed, or reduced to thin layers of membrane. The shoulder was free from pain and the joint healthy, but yet he was unable to lift the arm. There was no emaciation of the forearm or hand.

The muscular coat of the alimentary tube, and the bladder, are in some rare cases manifestly attenuated. Their walls become thin, transparent, withered, and pale. Sometimes an atrophied condition of the muscular coat of the alimentary tube is met with, analogous to that which is combined with the growth of fat; the muscular coat of the bowel becoming

thin, at the same time that fat accumulates in the mesentery, the omentum, and throughout the system.

Hypertrophy in the system of voluntary muscles, to an extent that would be called morbid, and would essentially disturb the functions of the part, is extremely rare, the tongue and a few of the respiratory muscles alone excepted. But it is very frequently observed in the heart, and in the muscular coat of the alimentary tube and bladder. The degree which hypertrophy attains in these organs is often exceedingly great. It is mostly due to some mechanical obstruction, to increased action and overstraining of the organ, to immoderate innervation, or, as in the instance of the bladder, to catarrh of the mucous membrane. After having reached a certain degree, it ends in palsy of the organ, and in this manner may destroy life of itself, and suddenly, or it may lead to various consequences, such as ileus in the intestinal canal, and inflammation and sloughing in the bladder, which in the end are fatal.

The deformities have partly been mentioned amongst the faults of development; the remainder are merely those which are produced by retraction, atrophy, and hypertrophy.

§ 3. *Variations in Colour*.—The colour of muscles varies much under different circumstances. Thus, as will appear in the latter parts of this chapter, diseases of their texture are attended by changes in their colour. When there is general emaciation, in dropsical subjects, in cachectic cases, such as rickets, tubercle, and chlorosis, after hemorrhages, &c., and in paralysed limbs, the muscles are paler than natural: in advanced life they have a pale rusty brown, or a dun colour. Muscles which waste in consequence of permanent spasmodic contraction, have a grayish or yellowish red hue, and at length become dirty white; when the atrophy is the result of steatosis, they are yellowish red; and so on. On the other hand, hypertrophied muscles are of a deep red colour; and those of persons who have died of typhus, acute convulsions, Asiatic cholera, or hydrophobia, of patients with scurvy and cyanosis, and of persons suffocated, are of a dark purple-red colour, with a shade of blue or violet. Muscles in the neighbourhood of collections of pus or sanies become brownish green, or greenish blue.

§ 4. *Deviations of Consistence.*—There is usually some connection between the deviations of colour and those of consistence: when muscles lose or change colour, they mostly become less firm; and when they have a deep red colour, their consistence is increased. Muscles thus altered may be in an unnaturally lax, supple, soft, and friable condition; or they may be compact and tough; or, again, though firm and glistening, they may be dry and easily broken. Thus, in the forms of cachexia just mentioned, the muscles are not only pale but lax; in old age and steatosis they are discoloured, and soft, they tear very easily, and may be squeezed into a pulp; whilst on the contrary, spasmodically contracted muscles are tough, notwithstanding their loss of colour. Hypertrophied muscles are firm and strong, and so are those of patients who have died of acute convulsions or hydrophobia, and especially after Asiatic cholera: in the last-mentioned cases they are also remarkably dry.

A still more marked instance of diminution of the consistence of muscles occurs in dropsy, and in the neighbourhood of inflammation and abscess. The muscles in these cases are not only bleached and discoloured, but also macerated. A peculiar softening of the muscular coat to a gelatinous substance is sometimes produced by the action of the acids of the stomach and intestines: not unfrequently the process reaches beyond the stomach and involves the diaphragm.

§ 5. *Solutions of Continuity.*—In this class are included flesh-wounds of various kinds, and the lacerations and contusions of muscles produced by external violence; some of them are unattended by any injury to the integuments, whilst, in other cases, that and other structures also are more or less hurt. Muscles are subject to spontaneous rupture, giving way now and then during violent convulsions. The accident, however, is a rare one in any muscular structure but the heart. I have, on several occasions, met with ruptures of the recti abdominis muscles, which had been produced by the convulsions that occur in the course of ileo-typhus. Not unfrequently a few of the muscles of the limbs are found ruptured in the dead body, and the occurrence may be traced to excessive post-mortem rigidity. I have observed it most frequently in the biceps muscle of the

arm. It may be distinguished as having taken place after death by the absence of any effusion of blood, and still more certainly by there being no trace of reaction.

The muscular coats of hollow organs do not usually escape laceration when the serous and mucous membranes, which invest them within and without, are violently torn; but sometimes the rupture is confined to the muscular coat. Not unfrequently it gives way in consequence of extreme distension, as for instance in the stomach, the intestine, and the bladder.

A wound of a muscle, though unattended by any loss of substance, can be repaired only in the same manner as one in which substance has been lost, for the retraction of the surfaces of the wound places the former in the same condition as the latter. Subcutaneous ruptures, those in which there is no corresponding injury to the superjacent integuments, and no exposure of the wound to the air, heal readily by the first intention: the surfaces become slightly inflamed, and a reddish, gelatinous exudation is effused, which fills up the space. It gradually changes into a reddish vascular cellular tissue, which at first unites with the surrounding inflamed cellular tissue, but afterwards separating again from it, is converted into a denser, white, leather-like (cellulo-fibrous) callus.

Flesh-wounds, which are complicated with injury to the integuments over them, and are consequently exposed, heal by suppuration and granulation. The granulations fill up the cavity of the wound, and changing into a dense white callus of the same kind, as in the former mode of repair, they unite the surfaces of the wound together. In such a case the inflammation extends beyond the wound for some distance along the muscle, and converts it into a cellulo-fibrous tissue, in which the muscular fibre disappears. The muscle is thus divided, and acquires two bellies; and not unfrequently a bursa is formed beneath the uniting callus, by which their movements are facilitated. In process of time this callus diminishes in size, partly by shrinking, and partly, perhaps, from being absorbed; and at length it may disappear almost entirely, a few traces of it only remaining.

In the stump, left after amputation, the extremities of the muscles become rounded off, and degenerate into a cellulo-fibrous tissue, and they unite in a common cicatrix with the integuments and thickened periosteum.

§ 6. *Diseases of Texture.*

1. *Hemorrhage.—Apoplexy.*—The various solutions of continuity, lacerations, and blows, which happen to muscles, give rise to effusions of blood within them: they are also liable to spontaneous hemorrhages into their parenchyma,—to extravasation of blood into their cellular and aponeurotic sheaths,—in fact to apoplexy. In cases of decomposition of the blood, trifling suffusions or ecchymoses occur in the muscles, as well as in the skin and subcutaneous cellular tissue; but in bad cases of scurvy and typhus, blood is extravasated from the capillaries rapidly and in large quantities, bruising and breaking the muscular fibres. Hemorrhages of this kind occur chiefly in the muscles of the lower extremities and abdomen, and are usually accompanied by effusions of blood into other tissues also.

2. *Inflammation.*—Inflammation of muscle (myositis) not only occurs as a consequence of the various injuries to which these organs are subject, whether incised, lacerated, punctured or gunshot wounds, or crushing, rupture, stretching, mechanical irritation, or concussion; but also arises spontaneously. It is sometimes a primary affection, and is brought on especially by the influence of cold; at other times it is a secondary consequence, either of metastasis, or of inflammation existing in adjoining organs. Its course may be acute or chronic. It is sometimes confined to a few scattered, and mostly small, spots in a muscle; at other times it invades the whole body of one, or of several muscles at once. As the cellular sheaths of the muscular fasciculi are almost always the seat of the process, especially if the inflammation be extensive, the distinguishing features of inflamed muscle will include those which characterise inflammation of cellular tissue. I must, therefore, necessarily refer to the latter, though attention will be chiefly directed to the change in the muscular tissue.

a. At first some redness and injection are perceived, and a little infiltration, of the interstitial cellular tissue; no change is discernible at this period in the muscular fibre itself.

b. But so soon as an actual exudation appears, the muscular fibre becomes discoloured; it changes to a pale red, a reddish-yellow, or a fawn colour.

c. If the inflammation continue, and the exudation be not

absorbed, an important change soon takes place in the texture of the muscle; the fibres lose their transverse striæ, and the fibrils degenerate into a granular mass.

d. The exudation presents various, and essentially different characters, some of which are due to the particular cause of the affection, and some to the state of the constitution.

Some kinds of inflammation deposit, in the interstitial cellular tissue, and between the muscular fibres, a gelatinous, grayish or grayish-yellow, product, which gradually solidifies and becomes a whitish lardaceous callus; inflammations of this kind are mostly slow in their course, and are attended by mild symptoms: they are commonly named rheumatic.

The product of another kind of inflammation is reddish or yellowish, and fibrinous, and readily coagulates; it becomes converted into fibroid tissue.

Others, again, lead to a yellow exudation, which degenerates into pus; after a time the product exuded is a fluid, and either purulent or sanious. Inflammations of this character frequently destroy entire muscles.

Lastly, there are some inflammations, the product of which is essentially tubercular, and softens like tubercle.

Now and then, in cases of scurvy, and in inflammations of paralysed muscles, a sanguineous product is found in the muscular tissue.

e. Under circumstances so various, the appearance of the inflamed muscle differs accordingly; its peculiar characters are most evident, when the inflammation is confined to isolated spots. The muscular fibres are then found in the midst of the exudation discoloured, disintegrated, and forming dull yellowish-red, or fawn coloured, and here and there interrupted, stripes. The exudation in which they lie may be a gelatinous, grayish, or grayish-yellow, substance; or firmer, and reddish or yellowish; or purulent and yellow; or tubercular and cheese-like; or red, filled with blood, and half coagulated.

f. An inflamed muscle is always somewhat shortened, and is paralysed in that position; so that the limb in which myositis occurs, is nearly or quite immovable; and if the flexor muscles be affected, it is fixed in the bent position. The muscle is bound also in another way; for its cellular and fibrous investments having taken part in the inflammation, it becomes

fixed in its sheath, and thereby also to other neighbouring parts, which may have been inflamed with it.

Inflammation of muscle, if it do not subside, may terminate in induration, in suppuration, or in gangrene.

When an intense inflammation subsides, it leaves the muscle wasted; and if there have been extensive inflammations, the whole limb shrinks, and affords an example of secondary atrophy.

Induration is a mode in which inflammation frequently terminates; it is often found to have occurred at some isolated spots, especially in the heart. The exudation in the inflamed part coagulates and becomes converted into a whitish, lardaceous, firm callus, which assumes a fibroid structure, but is still traversed by a few pale and broken muscular fibres. The appearance of the callus varies according to the original quantity of exudation: at first it forms cords and streaks, which ramify amongst the fibres and fasciculi of the muscle, or more extensive round, or nearly round, masses, which may be tolerably circumscribed, or may branch out irregularly in various directions. In the course of time, it may diminish in size considerably, partly from absorption, partly from its shrinking and becoming more dense, and from the disappearance of the muscular substance that still remains within it. As it thus diminishes in size, it draws in the surrounding tissue, and assumes the appearance of a deep cicatrix.

In a few cases this mode of termination has been found throughout the whole of a large muscle, and even in all the muscles of one or more of the limbs, particularly of the lower extremities: they were changed into a white tendinous structure, and here and there into bone.

Osseous substance may be developed at a later period in the fibroid callus (*ossification*); and, in a few cases, it has been seen occupying entire muscles.

It happens, but very rarely, that induration of the muscular coat of an organ may be traced to a chronic inflammatory process. I have met with one such instance in the muscular coat of the bladder. It was changed into a pretty thick and firm lamina, of an uniform pale red colour, inclining to yellow: the original bundles of muscular fibre had disappeared. It was closely united with the mucous membrane, but presented none of the peculiar change of texture charac-

teristic of cancerous degeneration. The bladder was paralysed and distended.

When inflammation of muscle terminates in *suppuration*, the matter may be formed at one or at several isolated spots; or if the process be extensive, rapid, and violent (tumultuous), it may involve the whole of the muscle at once. The abscess commences with the deposition of matter at several points; the intermediate muscular fibre becomes pale, or in some way discoloured, and is dissolved; the points of matter coalesce, and the gradual union of small collections of this kind at length destroys the whole muscle. When the suppuration runs a chronic course, the cellular sheath and outer layer of the muscle very commonly change into a thick lardaceo-fibrous membrane: in fact the muscle is converted into a thick-walled bag of matter. Certain muscles are particularly liable to be destroyed in this manner, such as the psoas, and the iliacus; and the disease is well known in the instance of the former muscle by the name of psoas abscess. The sac of the psoas abscess is spindle-shaped or cylindrical, and it is lined sometimes by a soft, diffuent, shreddy tissue, which is soaked in pus or sanies, sometimes by a smooth, grayish-red, or grayish lamina, resembling jelly; it may be full and tense, or collapsed, according to circumstances. At the insertions of the muscle into the bodies of the vertebræ, the sac not unfrequently spreads out into sinuses or pouches, while near the tendon it contracts like a funnel. Rounded bands of softened, or of lardaceo-fibrous and degenerated muscular substance, pass like bridges across the cavity; they take various directions, but are, for the most part, longitudinal. The crural vessels and nerves pass over the sac externally, and are stretched by, and adherent to it. The crural vein is not unfrequently found inflamed, and stopped by a plug of blood. In the further progress of the abscess, the centre of the tendon suppurates, and the sac, thus enlarged, appears below Poupart's ligament, and extends at last quite to the insertion of the tendon.

If the patient does not die from exhaustion at an earlier period, ulceration takes place in the wall of the abscess and the adjoining parts; the matter gravitates in different directions, and is occasionally discharged externally. Caries of the ilium

may ensue; the matter may pass under the fascia and among the muscles of the thigh, or towards the great sacro-sciatic foramen; and the abscess may open at the inner side of the thigh, in the abdomen above the groin, in the nates, &c.

In favorable cases the abscess heals up: the matter having been discharged or absorbed, the sac contracts and shrinks to a fibroid (ligamentous) cord, which sometimes retains in its interior chalky remains of inspissated purulent matter.

There is a very frequent combination with this abscess of muscle, and one of considerable importance, the relation of which to the suppuration in the muscle still requires explanation; I allude to caries of the bone into which the upper end of the muscle is inserted. Caries of the ilium, in cases of psoas abscess, is unquestionably consecutive; not so, however, caries of the lumbar vertebræ. This combination of disease in muscle and in bone, is certainly most frequently observed in the instance of the psoas muscle and the lumbar vertebræ; but it is sometimes found existing between the spine, and the tendinous crura of the diaphragm or the long muscles of the neck. I have met with it in other parts also, where muscles are inserted into spongy bones; for instance, at the insertion of the sartorius and gracilis, I have found the bone inflamed, and suppuration commencing in the interior of the tendon. The process is very rarely seen at its commencement; but from an analysis of the combination, as it has occurred to different observers, it seems that in some cases the inflammation and suppuration of the muscle is the primary disease, and the caries consecutive; whilst in others, the bone is first affected, and the abscess is formed chiefly by the subsequent collection and gravitation of the purulent matter.

From what I have had an opportunity of observing, it appears to me extremely probable, that in many cases the bone is the first diseased, whilst in many others the affection commences simultaneously in both structures; in the latter case it usually happens, that the suppuration in the tendon of the muscle spreads, especially at first, with most rapidity.

a. The caries, thus combined with abscess, is almost always of tuberculous nature: as, therefore, tubercle is a very common disease in bone, but is very rare in muscle, it is so far likely that the bone would be first diseased and the muscle afterwards.

b. But, on the other hand, I have met with cases which support the view, that the affection begins simultaneously in the bone and muscle,—cases in which at the insertion of the sartorius, the gracilis, or the long muscles of the neck, the bone was inflamed, and suppuration was commencing in it, whilst the tendon of the muscle formed a funnel-shaped abscess around the diseased spot of bone. Moreover it may be presumed, that this is the way in which the inflammation would extend to the muscle, when the bone is primarily affected.

When the disease has commenced in the manner last described, it extends into, and produces caries in the bone; while, on the other side, advancing from the point of the funnel-shaped cavity, it excavates the belly of the muscle: as it spreads it leads to the deposition of a tuberculous exudation, and reduces the muscle to a mere abscess, which communicates through the narrow sinus in the tendon with the ulcerating cavities within the bone.

The contents of the abscess are tubercular, purulent matter, and fragments of necrosed bone, infiltrated with tubercle.

3. *Metastasis in muscles*.—Deposits of purulent and sanious matter are sometimes found scattered extensively throughout the muscular system; they occur for the most part when pus or sanies has been taken into the mass of the blood.

4. *Gangrene of muscles*.—Sometimes inflammation terminates in gangrene; the muscular substance becomes much discoloured, and changes into a shreddy, almost diffuent mass, soaked through with sanies, and of a greenish-brown colour.

The state of the muscular substance is peculiar beneath an eschar, and in cases of mummification. It is converted either into a dirty reddish, soft, humid, spongy, pap-like pulp, or into a more dry, tinder-like, and fragile mass, that shrinks and crumbles together.

5. *Morbid growths*.—The muscular system is rarely the seat of morbid growths, except when it is involved in those which have originated in other tissues.

a. *Teleangiectasis*.—It occurs under the form of more or less extensive convolutions of dilated vessels, by which the muscular substance becomes displaced and atrophied, though at the same time the belly of the muscle retains its natural outline.

b. *Formation of fat*.—What is called conversion of muscle

into fat, or *steatosis musculorum*, is a change into a substance resembling adipocire or spermaceti, or into actual fat. The muscles most exposed to it are the voluntary muscles, especially those of the lower limbs: slighter degrees of the same change affect also the muscular substance of the heart, and the fleshy coat of the gall-bladder. There are two forms in which it occurs.

a. In the first, adipose tissue or fat cysts are formed between the ultimate muscular fibres: in the voluntary muscles the transverse striæ¹ disappear, and their red colour is exchanged for a paler hue, a pale yellowish-red, a dirty yellow, or a dun colour: after a time the fibres themselves become disintegrated and disappear, and the muscular tissue gives place altogether to a mass of fat. Small globules of free fat are found as well as fat cysts; and sometimes there is also a yellow granular pigment.

Many grades of this degeneration have been observed, which run imperceptibly into one another. They are distinguished by the external condition of the diseased muscle, which varies in respect to the amount of discoloration, the degree in which its texture is lost, and the preservation or alteration of its external form.

The earliest change is one of colour. The muscle has a pale reddish appearance; and is found, on close examination, to be not uniformly discoloured, but stained irregularly of a yellowish or fawn colour, as well as marked with longitudinal pale reddish streaks, which follow the course of the fibres.

As the stains of fat increase in size and coalesce, the muscle acquires an almost uniform fawn colour; but its fibrous arrangement still remains distinct.

With the advance of the disease it becomes altogether of the colour of fat; sometimes being yellow, sometimes remarkably white, and resembling accordingly either tallow or spermaceti. No trace of its fibrous structure remains except some of its tendon, or the cellular sheaths of its fasciculi.

Up to this stage of the disease the outline of the muscle has been preserved; but in the last stage the mass of fat, into

¹ It is not yet made out whether the disappearance of the transverse striæ is a primary or a secondary part of the change; but it is probably the former; for they disappear in paralysed muscles, under the same conditions as those under which *steatosis* takes place, though *steatosis* be not present.

which the muscle is changed, mixes with the adipose structures around it, with the subcutaneous adipose tissue, or with other masses of fat which have been developed by the same process in adjoining structures. We may then find in a limb nothing of its muscles, but remnants of tendons, and aponeuroses with their prolongations inwards.

A muscle thus diseased is usually very thin; and an extremity, in which all, or a great part of, the muscles have undergone such a change, is slender as if emaciated, and cylindrical from losing the contour of its muscles: it has also an uniform feeling of toughness.

These are the stages of the disease in question, from that at which it is first distinguishable by the anatomist, to that in which the muscle has completely disappeared, at least so far as opportunities of observing it have occurred to myself and others. In its first and slightest degree it is closely allied to that state of emaciation and pallor in which the animal muscles are found when there is a great and general deposit of fat in the body, such as occurs chiefly in the female sex, and is associated with changes in other organs, which will be mentioned afterwards. It is allied, also, to the state of atrophy of the organic muscular coat of the bowel, and even of the bladder, &c., which is found when large quantities of fat are accumulated in the folds of the peritoneum and cavity of the pelvis.

The process consists, therefore, in the production of a quantity of fat, which compresses the muscular fibres; and the name of fatty metamorphosis of muscle can be applied to it only in so far as the place of the muscle is actually occupied by fat.

Whether the disease occur in one muscle or in many, it usually commences at every part of them at once. Sometimes, however, it appears first at several isolated spots on the surface or in the interior; or it terminates at particular points, as is especially the case in the heart.

It is met with in the substance of the heart, and in the fleshy coat of the gall-bladder, but is most common in the muscles of the lower extremities.

Among the causes which lead to it, we are able to enumerate advanced age, a sedentary luxurious kind of life, the misuse of alcohol, and complete inaction of the muscles,—such inaction

as is produced by ankylosis, or by spasmodic contraction of some other muscle.

The fatty degeneration which is brought on by a sedentary and luxurious mode of living, and by spirit drinking, is, for the most part, accompanied by a great development of fat throughout the system; the liver usually contains a quantity of tallowy substance, the heart is loaded with fat, and its muscular tissue is more or less metamorphosed into the same substance: moreover, in old people more particularly, the medulla of the bones connected with the altered muscles is in excess, and the bones are in a state of osteoporosis, or excentric atrophy, and are easily broken.

The fat by which the muscular tissue is supplanted varies in its character. In some instances it resembles ordinary healthy fat; sometimes, especially in persons advanced in years, it is of a dark yellow colour, loose and diffuent; and sometimes, in its consistence and whiteness, it is remarkably like mutton suet. It assumes this last character particularly when the change results from ankylosis.

β. There is another form of degeneration which has not been hitherto observed, and to which the muscular structure of the heart is liable, particularly when hypertrophied: it is met with, also, but not so frequently, in the muscular coats of other organs when they are hypertrophied, but is very seldom seen in the muscles of animal life. It is characterised by the development of minute particles of free fat between the primitive muscular fibres. At the same time the striated sheath of the fibre disappears, and the muscle changes to a dirty yellow or fawn colour, and becomes friable. I once met with the disease in the muscles of the calf, in which it had given rise to considerable pain: this fact coincides with the experience of other observers.

c. *Cysts*.—With the exception of cysts which enclose entozoa, these growths are very rare in the muscular system. Even the large-sized acephalocyst sacs are very seldom found. And this recalls the fact, that cancerous growths also are extremely uncommon in muscles, although a comparison of this sort leads to no result, inasmuch as muscles are rarely the seat of morbid growths of any kind.

d. *Fibroid tissue* is found in muscles which remain indurated

with callus after inflammation, and in those which are spasmodically contracted.

e. Bony growths (1,) not unfrequently exist in muscles in the form of calcareous concretions, which have been developed in the fibroid tissue just mentioned. In some few cases, whole muscles have been found thus ossified. Muscles sometimes contain also the cretaceous remains of pus, of tubercle, and of the shrunken sacs of the cysticercus and acephalocyst (echinococcus).

(2.) True bone is less frequently met with in muscle. When it occurs, it assumes a rounded form, or is flattened and elongated, but still rounded. Sometimes it is spongy, and sometimes of more compact structure. The drilling bone (*Exercirknochen*), as it is called, in the left deltoid muscle, is of this nature, and numerous other growths of the same kind are to be met with. In the Museum at Vienna, a very large, egg-shaped, piece of bone is preserved, which was taken out of the biceps of a woman's left arm.

f. Tubercle.—Primary tubercle scarcely ever occurs in the muscular system, least of all in the form of gray granulations. Even those inflammations of muscles which have been already mentioned as leading to tubercular deposition, and as connected with similar affections of bone, are, generally, secondary inflammations; they almost always occur in combination with tuberculosis of parenchymatous organs, and especially with already established tuberculosis of the lungs. Under similar circumstances, and according to my observations when phthisis already exists, inflammations now and then arise independently of diseased bone, in the interior of the bodies of different muscles; they furnish an exudation of tubercular nature, and as this breaks down, they give rise to the formation of a tubercular vomica in the muscle.

But muscles sometimes become the seat of tubercle and tubercular softening, in consequence of their vicinity to other affected organs; and this is especially the case with organic membranous muscles, particularly with the fleshy coat of the intestinal canal. The fact is seen in the muscles surrounding the thorax when there has been tubercular softening of the lung and pleura, in the muscular coat of the bowel beneath a tubercular ulcer of its mucous membrane, &c.

g. Cancer.—In whatever form this disease presents itself, it is scarcely ever the primary cancerous affection in any muscle of animal life, except the tongue. One or more cancerous growths are almost always found elsewhere, and that in the muscular system is the secondary affection. Of those organs even which are entirely composed of organic muscular fibre, nearly the only one which is ever primarily attacked by cancer is the uterus; and it is the cervix and vaginal portion of the uterus,—the muscular development of which is in the unimpregnated state very subordinate to that of its body,—that is especially subject to the disease. But muscular tissue is more frequently involved in the degeneration of adjoining organs affected with cancer, and to this secondary affection both animal and organic fibre is subject; the pectoral muscle, for instance, in cancer of the breast, and the muscular coat of the alimentary canal in cases of cancer of the stomach or bowel.

The forms of cancer which are most frequently observed thus attacking the muscular system, are the fibrous and medullary.

A firmly fixed knotted tumour, inwoven with the muscular tissue, and sending out branches in all directions, is sometimes the distinguishing character of the fibrous kind of cancer; but more frequently, when the muscle is diseased in consequence of its proximity to some other affected organ, it produces a characteristic degeneration of the muscular tissue. This degeneration is mostly seen in cases of secondary disease of the pectoral muscle, or middle coat of the intestines, and it leads to the conversion of the muscular tissue into a white, fibrillated, reticular structure, in the interspaces of which a pale reddish, or yellowish-red substance resembling firm jelly is lodged. The muscular coats of organs, under such circumstances, are palpably increased in size. Degeneration of the same kind is observed not only in fibrous, but also in medullary cancer.

The medullary form is not unfrequently associated in muscles with a very extensive growth of cancer. It sometimes presents its genuine white character, sometimes that of melanosis; and it grows in rounded, circumscribed, encephaloid knots, in one or in several muscles. When the muscle is diseased in consequence of the degeneration of adjoining organs, encephaloid matter seems to be infiltrated throughout it amongst the mus-

cular fibres, some of which are blanched, and others degenerated in the same manner as in fibrous cancer.

Like other structures, muscle sometimes resists for a long period the advance of large cancerous growths: it becomes thin and atrophied from the pressure and stretching, but undergoes no actual change of texture.

h. Entozoa.—The entozoa which occur in the muscles of the human subject, are—

a. The echinococcus, which inhabits the acephalocyst. It is seldom met with. The sac is situated between the fibres, and forces them more or less asunder.

β. The cysticercus (*Blasenschwanzwurm*) is somewhat frequent. It is very often found in several or in most of the muscles, as well as in the heart of the same individual, and not very rarely in the brain too. The number existing in a single muscle, and in one individual, is sometimes quite extraordinary. The cysticercus seems to share with the *trichina spiralis* the remarkable character of being confined to voluntary muscles (muscles with transverse striæ); the distinction is not perhaps so strictly marked as in the instance of the *trichina*, but it has been observed in several cases.

When the cysticercus dies, its tail-vesicle shrinks, and the contents become inspissated, and at length cretaceous. Chalky concretions enclosed in a thick cyst are often found in muscles, which are the remains of cysticeri.

γ. The *trichina spiralis* is an entozoon which is strictly confined to the voluntary muscles. Upon its death it leaves an encysted chalky concretion behind.

i. Foreign bodies.—All kinds of extraneous bodies are introduced into muscles by natural or unnatural means, such as needles, bullets, fish-bones, &c.

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PART XII.

**ANOMALIES AND DISEASES OF THE NERVOUS
SYSTEM.**

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PART XII.

ANOMALIES AND DISEASES OF THE NERVOUS SYSTEM.

THE abnormal conditions of the nervous system may be subdivided into those of the brain, those of the spinal cord, and those of the nerves. To the description of the two former I shall prefix an account of the disorders of their investing membranes.

CHAPTER I.

THE BRAIN.

SECT. I.—ANOMALIES AND DISEASES OF THE MEMBRANES OF THE BRAIN.

THE membranes of the brain become involved both in faulty development, and in structural diseases of the cranium on the one side, and of the brain on the other. They are liable also to many idiopathic diseases.

DURA MATER.

§ 1. *Deficient and excessive development.*

1. This membrane is sometimes entirely wanting in consequence of the absence of the brain; and portions of it are deficient, when the development of the brain is in any way arrested; thus the tentorium or the falx is sometimes wholly or partially wanting.

2. When the brain is double, there are two more or less complete sacs of dura mater.

§ 2. *Anomalies in Size, Form, and Position.*—These include the unnaturally small or large capacity of the sac of the dura

mater, which results from corresponding anomalies in the formation of the brain, whether want of symmetry between its two halves, or displacement of them from their natural situation; or which results from an unnatural direction of the falx, from partial dilatation and (hernial) protrusion through the cranium, &c. And at any period of life, the dura mater may be distended and more or less attenuated, and its internal processes displaced in various directions by hypertrophy of the brain, hydrocephalus, morbid growths in the brain, &c.

The thickness of the dura mater is often manifestly increased, not only in consequence of inflammation, but also in persons who are advanced in life. Sometimes also it becomes thin, either in its whole extent, as when the brain is hypertrophied; or at certain parts where it is subjected to pressure; thus it is found thin and cribriform where it has been exposed to the pressure of the Pacchionian bodies.

§ 3. *Solutions of Continuity.*—Under this head we class together anomalies in the adhesion of the dura mater to the cranium, and solutions of the continuity of the membrane itself.

Besides the thickening which the dura mater undergoes in advanced life, it acquires also a closer adhesion to the cranium; for as new bony matter is at different periods deposited on the inner surface, especially of the vault of the cranium, and the number of vessels with their investments passing between the membrane and bone becomes increased, the union between them is rendered more intimate. The adhesion generally commences, and continues strongest, along the sutures. In very old age the adhesion is often remarkably less firm than it is in middle life; the cranial bones are then atrophied.

The adhesion between the dura mater and cranium is frequently rendered much looser, or even entirely broken for a more or less considerable space, by concussion of the skull; the separation may take place at the part where the blow was struck, or on the opposite side of the head. Its extent is often increased by subsequent extravasation between the membrane and the bone. Purulent and sanious effusions gradually force the dura mater and the bone apart.

The dura mater and cranium are frequently found separated

from one another in cases of cephalhæmatoma, by an extravasation of blood, which takes place spontaneously from the bone.

Various kinds of solution of continuity befall the dura mater from incised, punctured, and gunshot wounds, and from injuries which break and shatter the skull. The membrane may split also, from being much distended by pressure from within in cases of hydrocephalus; and these ruptures of the dura mater are not limited to cases of hemicephalus; in some extremely rare instances, rupture occurs in hydrocephalus during extra-uterine life. Such a case is preserved in the Vienna Museum; it is a rupture of the dura mater, near the right parietal protuberance, more than an inch in length; it occurred in a hydrocephalic boy, and was followed by the extravasation of blood and of serum from the ventricle, between the dura mater and the cranium, and thence under the pericranium.

The Pacchionian bodies very often exert such pressure on the dura mater, as to give rise very gradually to solution of its continuity and concomitant atrophy. They force the fibres of that membrane asunder, and having pressed through it, lie in immediate contact with the skull.

Somewhat rarely it happens, that the dura mater is forcibly separated into layers by an extravasation of blood within it after concussion of the skull: such a separation is still more rare as a consequence of suppuration. Those extravasations which have been supposed to be collections of blood between the serous and fibrous strata of the membrane, with the exception of a few cases in which a small effusion has raised its innermost layer, must have been extravasations into the sac of the arachnoid which, after acquiring an adhesion to the dura mater, have become encysted: they will be considered among the diseases of the arachnoid.

§ 4. *Diseases of Texture.*—A distinction will be drawn in the following remarks, wherever it is possible, between the actual dura mater, and its innermost shining stratum. For, though the latter cannot be demonstrated as a separate serous layer, we are compelled to adopt the distinction by the substantial difference which is exhibited, at least at first, by morbid processes in the two layers. Inflammation, for instance, attacks one of the layers independently of the other, and presents dif-

ferences accordingly in its course, in its proneness to extend along the surface, and in the products it furnishes, which manifest the analogy between that layer and serous membranes in general. I shall not at present enter into these, or into several similar subjects, as it would be interfering with diseases that are evidently connected with the arachnoid membrane.

1. *Inflammation*.—With the exception of those which are brought on by injury, primary inflammations of the dura mater to any extent, such, for instance, as would lead to the formation of matter, are of rare occurrence.

Inflammations of slight degree, on the other hand, and usually combined with moderate inflammation of the cranial bones, are frequent. These processes are characterised by vascularity and rosy reddening of the dura mater, and by softening of its texture; and they give rise to interstitial infiltration of the membrane, as well as to exudations upon that surface of it which adjoins the bone: such exudations become organised into loose cellular, or thick fibrous tissue, or at length, especially if there be any inflammation of the bone besides, into bone; and they produce an unnatural adhesion to the vitreous table of the skull. They are generally widely spread, especially along the sutures; but sometimes they are confined within a smaller compass, so that they form at one time extensive tracts, at another circumscribed islands. Exudations which ossify, very commonly present themselves spread out as a layer, that, like the puerperal osteophyte, is at first spongy, but gradually becomes compact: sometimes they form a mass of bone which looks as if it had flowed or dropped upon the membrane, and then coagulated; while, not unfrequently, they are circumscribed osseous plates or nodules, which though, in course of time, intimately united to the bone, yet originally adhered firmly to the dura mater.

When the inflammation is more intense, and runs a chronic course, the dura mater acquires an increase in thickness, sometimes to the extent of three lines, and even more; it becomes indurated and callous, and usually adheres more closely than natural to the bone. I met with an instance of this effect of inflammation in the dura mater lining the right occipital fossa, in which inflammation came on in the adjoining lateral sinus, and led to its obliteration.

When inflammation is brought on by injury, or passes to the dura mater from neighbouring tissues, it frequently terminates in the production of matter, and in suppurative degeneration of the membrane.

These latter cases, therefore, are of great importance, for they are brought on by inflammation and suppuration of the bone, or of neighbouring ligamentous structures. They are especially apt to occur in particular localities; thus the dura mater inflames, suppurates, and sloughs from caries of the internal ear, and the labyrinth of the ethmoid bone, from caries of the upper cervical vertebrae, and suppuration of their ligaments. In the dura mater these processes continue circumscribed, but when they reach the inner membranes, they usually spread rapidly into general meningitis.

The characteristics of inflammation of the dura mater are those which are common to all inflamed fibrous tissues: I refer on this point to what has been said at page 111.

2. *Adventitious growths.*

a. *Cysts.*—Cysts properly belonging to the dura mater are extremely rare; though some examples have been met with in its substance of fat-cysts containing hair. I have in some cases seen tumours attached to the inner shining surface of the dura mater, which resembled lipoma; they were inclosed in a cellular sac, and more or less distinctly lobulated.

b. *Fibroid tissue.*—Besides the fibroid thickening of the dura mater which is found after inflammation, tumours of fibrous structure occur in that membrane. They are, however, very rare; in a great number of tumours I remember only some few which exhibited a genuine, developed, and undoubted fibrous structure. Very many growths in the dura mater have indeed an intermixture of fibres with their structure, differing in various cases in arrangement and degree, which gives them the appearance of a fibrous tumour. There is no doubt that the tumours on the petrous bone, particularly examined by Cruveilhier, were structures of this class supposed to be purely fibrous.

c. *Productions of bone.*—What are called ossifications of the dura mater, are known to be very common. By these are generally meant the bony growths situated on the inner surface of the dura mater, especially of the falx. I do not, however, believe that these belong to the dura mater itself. From their analogy with similar formations on the cerebral, and especially on the

spinal, arachnoid, as well as from special examination of their relations, I infer that they are connected with the arachnoid layer of the dura mater. They will be noticed more completely among the abnormal conditions of that membrane.

There are, however, some bony formations which undoubtedly belong to the dura mater. The osseous plates before alluded to, which become united to the cranial bones, and which are true bone, and the bony concretions sometimes developed in the dura mater, when it has become thickened and callous from inflammation, are of this kind.

d. Tubercle.—Primary tuberculosis is as rare in the dura mater as it is in the fibrous system generally. The tubercles, which are often found adhering to the inner surface of the dura mater, are such as were originally developed in the peripheral cerebral substance, and subsequently came into connection with the dura mater by the formation of adhesions between them and the inner membranes. They do not belong, therefore, to the present section. On the other hand, the dura mater is not unfrequently the seat of tubercular deposit and tubercular suppuration, when the cranial bones are carious from tubercular disease.

e. Carcinoma.—Even excluding from consideration the various growths of cancerous nature, and those more or less allied to cancer, which present themselves on the internal shining surface of this membrane, we yet find cancer of the actual dura mater to be of rather frequent occurrence. It sometimes exists primarily, that is originates, in the dura mater; but much more frequently the membrane becomes diseased secondarily by its contiguity with the cranium,—cancer of the bone implanting itself in the dura mater after having perforated the vitreous table. Even cancers of the brain sometimes implicate the dura mater.

Primary cancer appears—

a. In the form of cancerous infiltration of the tissue of the dura mater, in tracts which are mostly considerable in extent. The membrane is thickened to a corresponding extent, and the surface next the bone is often covered with a layer of cancerous matter, which makes its way into, and destroys the cranial bones: at length the disease appears also on the inner surface of the dura mater, destroys its arachnoidal layer, and spreads out in the sac of the arachnoid in the form of one uneven rugged

stratum, or of separate nodulated protuberances. It is always combined with cancer in other organs, and assumes the form of white encephaloid, or of cancer marked with black pigment.

β. In the form of rounded tumours, which commence in the fibrous tissue of the dura mater, and protrude, as they grow, either outward or inward, or in both directions. It is sometimes found alone; very commonly it is of the medullary kind; it is often characterised by fibrous arrangement, and often, too, by considerable vascularity; or it resembles in its structure the parenchyma of some glands.

This last form exactly corresponds to the morbid growth which has been, and indeed is still, known by the name of fungus of the dura mater. The question, as to whether the dura mater or the calvarium be its primary seat, is no longer important, as it is settled in what has just been said; and the discussion which has been carried on upon the subject has now only an historical value.

If the fungus grow outward, it makes its way, by the pressure and absorption which it occasions, through the skull, and appears under the integuments: after a time it perforates them also. The loss of substance is more extensive at the inner than at the outer table; and as the fungus, after having perforated the skull, swells out and grows without restraint, it is girt by the sharp bevelled margin of the bone, and a constriction, or kind of neck, is produced. This condition of parts has been looked upon as very characteristic of these cases, it is, however, far from being universal; it is not found, for instance, when the bone degenerates together with the fungous growth, when it is by the malignant degeneration of the bony tissue that the fungus makes its way to the surface; still less is it found in cases in which the fungus of the dura mater was originally a fungus of the cranium, or in the stage of softening of the fungus, in which the aperture becomes enlarged by corrosion of the bone.

The usual situation of cancer of the dura mater is the vault of the skull; it seldom happens at the base. If it spread as a fungus inward, the bone beneath it commonly becomes thickened and dense, or the fungus springs from the dura mater just over a plate of new bone.

THE ARACHNOID.

The arachnoid is a shut sac, the visceral or cerebral layer of which is, for the most part, blended with the pia mater in the same manner as serous membranes are with the tissue which lies beneath them: but in some parts, which vary in extent, it departs from this relation to the pia mater, and is thereby distinguished from serous membranes; that is to say, by being unconnected with any subjacent tissue, and by having a double smooth surface. And corresponding to this peculiar anatomical arrangement, there are various features in diseases of the inner membranes (arachnoid and pia mater), when regarded as one organic whole, by which they are distinguished from diseases of other serous membranes. It is desirable that the diseases of the arachnoid should be considered apart from those of the pia mater, because the former, especially in its parietal layer, is subject to many affections which are peculiar to itself, and because the diseases of its visceral layer also are in many respects independent of the pia mater: moreover, there appears to be less confusion in studying the relations of two things in separate and adjoining sections, than in overwhelming one section with differences and peculiarities, and speaking sometimes particularly of one, sometimes of the other, and sometimes of both.

§ 1. *Anomalies in size.*—To this head belong congenital enlargements of the arachnoid; they are produced by what is called external or meningeal hydrocephalus, and are either partial (local) or general. The former are cases in which sacs of a dropsical arachnoid protrude through an aperture in the skull. I shall have to treat of these cases among the Anomalies of the contents of the arachnoid sac.

§ 2. *Diseases of Texture.*

1. *Hyperæmia.*—We very rarely have an opportunity of seeing the vessels of the arachnoid in a state of congestion, or, indeed, of detecting any injection of them that is perceptible with the naked eye. But changes, nevertheless, are frequently discovered in the membrane, which can be attributed only to congestion, or to slight and passing attacks of inflammation,

and which are always accompanied with changes in the pia mater of a similar nature, and arising from the same source.

These changes increase in degree with each recurrence of the congestion, but they are found to be most marked when it has become habitual. The cerebral arachnoid is the most frequently affected, especially that portion of it which covers the convexity of the cerebral hemispheres. The changes consist in opacity, thickening, and hypertrophy. Sometimes large extents of surface are pretty uniformly affected, at other times separate spots are more prominently, or are alone altered. The arachnoid tissue is opaque, dull like whey or milk, tumid and white, and it has the appearance and density of tendon. One form which the affection assumes is remarkable for its frequency; it is well known by the name of the Pacchionian bodies. They are merely a granulated form of fibroid thickening of a serous membrane. The granulations are found both singly and in groups, and when they exist in any number, they are generally situated upon an arachnoid membrane that is cloudy and thickened. By their pressure they force the fibres of the dura mater asunder, and become imbedded in it; then perforating that membrane, they occupy small pits and fossæ of their own in the cranial bones, and in this manner give rise to an unnatural adhesion between the cerebral arachnoid and the dura mater. They are usually found at the margin of the hemispheres adjoining the falx, and in that situation they often perforate the wall of the superior longitudinal sinus, and project within its cavity.

Opacity and thickening of the arachnoid are very common post-mortem appearances: after middle life, a moderate degree of them is almost constantly found, and their absence is the exception; for at that period every one must have been exposed to repeated congestions of the brain and its (inner) membranes. This is especially true of the Pacchionian bodies, which, as is well known, are scarcely ever absent, even in earlier life. In persons who have suffered from frequent, intense, and protracted congestions, they are more considerable; but the most marked examples succeed the congestions produced by frequent intoxication, and repeated attacks of delirium tremens.

Moreover, the arachnoid membrane is found augmented in actual bulk, and containing within its cavity an increased

quantity of serous effusion, in cases of atrophy of the brain, and, indeed, in combination with various other appearances, which are all occasioned by the tendency to a vacuum within the cranium, and will all be detailed in the sequel.

2. *Hemorrhage*.---Spontaneous extravasations of blood into the sac of the arachnoid are by no means uncommon. They mostly happen on the convex surface of the hemispheres; at least, in the more extensive effusions, it is always in this situation that the largest quantity of blood is accumulated; small effusions frequently take place at the base of the skull, but larger ones occur there very rarely. They are seldom met with while in the recent state; and from their having usually existed for a long period before they are examined, the effused blood is found to have already undergone considerable changes. I will begin by depicting a well marked example, and afterwards analyse its appearances.

Lying beneath the dura mater that covers one of the hemispheres, is found a sac or cyst, which resembles in form a flattened cylinder, somewhat curved from before backward in correspondence with the arch of the cranial vault, or resembling in shape what results from the forcible separation of two layers of a tissue by an effusion which commenced at some single point, and then spread out between them. The figure first described involves an excess in the measurement from before backward over the transverse and the vertical diameters. The sac adheres by its outer surface to the dura mater, but its inner wall is free, or nearly free, from any connection with the cerebral arachnoid, and is consequently more or less smooth, and moist. Its adhesion with the dura mater, too, is but loose; it partly sticks on, and partly is connected with the membrane by a few small vessels. Both walls of the sac are usually of a brown, rusty colour, and tenacious; they may often be separated into several layers which vary in thickness, but the inner of which are the more thin: at the margin of the sac they coalesce and form one lamina, which soon becomes reduced to a thin, brown, rusty-coloured membrane, and spreading out further on the cranial vault, reaches to the base, and at length terminates in a thin, rusty-coloured, gauze-like film. Loose shreds of plastic lymph hang on the inner surface of the walls, and (which is remarkable) principally on the wall which adheres to the dura mater; within

these the sac contains a more or less thick fluid, of a dark and various colour, like chocolate, or plum-sauce, rust, or yeast: in course of time the lymph is gradually removed, the inner surface of the sac becomes smooth and polished, and the contents are changed into a colourless, thin, clear, serous fluid. The corresponding hemisphere becomes plane or slightly hollowed, its convolutions flattened, and its ventricle narrowed, while the serum of the ventricle is forced over into that of the opposite side. The pressure of the cyst sometimes diminishes the thickness of the parietal bone.

On closer examination, the outer layers of the wall of the sac are found to be vascular. At the margin of the sac, just where its two walls unite into one stratum, numerous small trunks may be seen, sending branches and twigs both upon and into the walls, especially that wall which adjoins the brain. Here and there also other vessels pass into the convex surface of the sac from the dura mater. The walls are composed of plastic lymph, and contain various quantities of modified red particles of the blood; in their outermost layers fibrils like those of cellular tissue are being developed. The coagulation of this lymph at the periphery of the effusion, is the occasion of its becoming encysted.

These sacs are usually borne for a long time, and they do not present any proof of having diminished from their original size; for the impermeability of the wall of the sac materially interferes with the absorption of its fluid contents. Occasionally, however, cases do occur, in which a sac that originally was of large size, has undoubtedly become smaller, some of the fluid part of the contents having been at length absorbed, and the cavity diminished by the approximation of the two walls to each other, and by their cohesion at the margin of the sac. In some cases it has even completely closed in this manner, and is wasted.

The walls of the sac, especially that one which adheres to the dura mater, sometimes become the seat of ossification, that is, of bony concretions in the form of plates.

In a considerable number of observations, I have seen but one case in which the sac was of cylindrical form, and filled, like a sausage, with a dark, reddish-brown plug of coagulated blood.

Some rare instances occur of large circumscribed extravasations into the arachnoid sac, in which the fibrin does not disengage itself, and coagulate at the surface, and thus inclose the extravasation; such cases present to view a rounded and irregular mass of coagulum.

Small effusions, which spread out and form a thin stratum, leave behind them a correspondingly thin, single lamina, of a rusty brown, or yeast-yellow colour, which lines the dura mater. It is very often a mere film, and can be detected only by the closest examination.

According to my observations, these extravasations occur pretty often in adults, and especially during and after the best years of manhood: Barthez, Rilliez, and Legendre, have not unfrequently noticed them in young persons and children. It has been my uniform experience, that the large encysted extravasations over the hemispheres, induce a marked degree of weakness of intellect. They have much general interest, as rare examples of hemorrhage into a serous cavity. The source of the bleeding cannot usually be discovered. In persons who are advanced in life, it may, perhaps, arise from the congestions which are occasioned within the skull, by atrophy of the brain.

It should be remarked, that old effusions may be mistaken for hemorrhagic exudations; but such an error may be obviated by observing the following particulars:

a. At whatever period the extravasation may be examined, no change of structure, such as accompanies inflammation, will be found in the arachnoid, even in its parietal layer, to which the extravasation is attached.

β. In the recent state, it is clear that the effusion is pure blood.

γ. Further distinctions may be noticed, in the peculiar change of structure which has been described as taking place in the extravasated fibrin, and in the want of any intimate organic connection between the sac and the dura mater.

Lastly, it is these encysted extravasations which have hitherto, for a long time, been erroneously looked upon as extravasations between the two layers of the dura mater.

3. *Inflammation (Arachnitis, Arachnoiditis).*—The condition of the pia mater subjacent to an inflamed arachnoid membrane,

produces sundry peculiarities in inflammation of the cerebral layer of the arachnoid.

In the first place, inflammations of the parietal layer of the arachnoid are, on the whole, of frequent occurrence; their pathological import, however, is mostly subordinate, for they are a secondary appearance, or, as it were, a complementary localization of the general disease: they occur in the course of processes attended with extensive exudations, particularly of those which take place on serous membranes; they are met with, also, in cases of what is called a phlogistic state of the blood, and in pyæmia, in the course of acute exanthemata, of Bright's disease, of acute biliary dyscrasia, &c.; and they are commonly slight in degree. The inner surface of the dura mater appears streaked with delicate vessels, and is of a clear, rosy red tint; it is lined with an exudation, that may be delicate, grayish, and soft, like a layer of mucus, or more consistent, and membranous, or yellow, loose, and puriform.

In some rarer cases, the inflammation of the parietal layer has all the appearance of being primary, and, judging from the amount of its products, severe also. The inner surface of the dura mater is found lined with a false membrane, from half a line to several lines in thickness; it is of cellular structure, and is mostly remarkable for its vascularity, and for a corresponding degree of redness. It is attached to the dura mater by means of its vessels. Sometimes it contains yellow cheese-like masses of disorganised fibrin, which vary in size, and in shape are rounded or irregular, and branching and coalescing. Still more rarely, the exudation becomes a dense, fibroid membrane, in which plates of bony concretion are developed, as so often occurs in false membranes on the pleura.

These processes usually take place, and furnish their products without being accompanied by any similar disease in the cerebral layer: even in the intense primary inflammation mentioned last, the change which takes place in the cerebral layer, is limited to cloudiness and thickening; the false membrane very rarely produces any adhesion between the two surfaces.

Inflammations of the cerebral layer of the arachnoid mem-

convexity of the hemispheres, and in the shape of plates, which are smooth on their free surface, and rough on that by which they are attached.

The so-called ossifications of the dura mater are met with mostly in advanced life; their essential importance is far less than that which is usually attributed to them, and they become still more insignificant in proportion as the atrophy, to which the brain is liable at this period of life, increases. As a general rule, they are certainly of moment, when found before the thirtieth year of life. They very commonly coexist with hyperostosis of the cranium, thickening of the vitreous table, especially near the forehead, with adhesion between the dura mater and the skull, cloudiness, and thickening of the inner membranes, &c.

They are composed of true bone, and usually have also a very compact texture.

In some very rare cases bony formations of other kinds are found scattered over various parts of the inner surface of the dura mater, and the opposed layer of the arachnoid. They are crumbling or firm concretions, of a reddish, or a white colour, and resembling mortar, and are most probably cretified fibrinous exudations.

d. Cancers.—Adventitious growths which belong to the present section, frequently occur on the inner surface of the dura mater; they are quite remarkable for the variety of their external appearance and of their elementary structure. Thus, in regard to the former particular, we meet with delicate villous, vascular, fungous growths, with thoroughly encephaloid formations, with tumours minutely divided into acini, like some glands, with lobulated masses variously streaked with fibres, and so forth.

e. Tubercle.—The rare occurrence of exudations to any amount on the free surface of the arachnoid, while they are quite common in the tissue of the pia mater, probably explains why the arachnoid, unlike other serous membranes, should scarcely ever be the seat of tubercular deposit,—why meningeal tuberculosis in every form is restricted to the deposition of tubercle in the tissue of the pia mater.

§ 3. *Anomalies in the Contents of the Arachnoid.*—Some of these anomalies have been already detailed; the accumu-

lation of serous fluid in the arachnoidal sac in any beyond the natural quantity, constitutes another instance of them. When the accumulation is considerable, it constitutes the disease which is known as external, or meningeal, hydrocephalus. Sometimes it is congenital, and is then remarkable for the great quantity of the serum.

It appears in two forms :

a. In that of dropsical sacs, which consist either of arachnoid membrane alone, or, as is more common, of dura mater also, identified with the arachnoid, and attenuated in an extreme degree: they protrude through an aperture in the skull, and form a diverticulum of the arachnoid sac, which communicates with the general cavity by a narrow canal. If, as is very commonly the case, there be no complication with hernia of the brain, such sacs are undoubtedly curable by being emptied and tied.

b. The second is a uniform accumulation of serum in the arachnoid sac, by which the brain is displaced and compressed towards the base of the skull, and the cranium is, at the same time, uniformly enlarged. Although there are some cases, and one in particular in the Vienna Museum, which show that this hydrocephalus may attain very considerable dimensions, yet such an enlargement is extremely rare.

There is an excessive accumulation of serum in the arachnoid sac which comes on very frequently during extra-uterine life, and calls for some remark.

The normal quantity of serum in children is just sufficient to keep the free surfaces of the arachnoid membrane moist; it may be a few drops, but it does not exceed a drachm; in adults it amounts to three or four drachms. This quantity is found collected in the posterior fossæ of the skull; and if the brain have been carefully removed, it remains in its natural clear and colourless condition: but as in examining and taking out the brain, some blood is usually mixed with it, it appears turbid, and is more or less tinged red.

When there is an excess of this serum, not only has a greater quantity gravitated to the base of the skull, but a part of it also pours out when the dura mater is slit at the mid-height of the brain, along the line where the skull has been divided by the saw. The whole amount may often be estimated at an ounce, an ounce and a half, two ounces, or even more.

The conditions under which considerable quantities are found, are principally two: they may occur,

1. In consequence of frequently recurring habitual congestion of the membranes, or of a varicose state of the vessels of the pia mater.

2. As a result of atrophy of the brain. Under both conditions the excessive accumulation of serum in the arachnoid sac, is combined with thickening of the inner membranes—the cerebral arachnoid, and pia mater,—with infiltration (œdema) of the pia mater in atrophy of the brain, with accumulation of serum in the ventricles, and sometimes with a state of infiltration or œdema of the brain. It is always important to notice that serum is accumulated at the same time beneath the bridge-like expansions of arachnoid at the base of the brain, especially in the cerebellum; and the more so as the fluid escapes from the latter situation when the brain is removed, and augments the quantity which is found in the arachnoid sac.

This serous effusion into the arachnoid sac, is essentially chronic; but it is subject to sudden or to gradual increase with every attack or augmentation of the congestion, with every advance in the varicose state of the vessels, and in the case of atrophy of the brain, as the vacuum becomes greater within the skull. It is an important question whether there are any acute effusions of this kind, which are rapidly fatal; and whether it is possible to recognise them on the dead body as the cause, or as part of the cause, of that form of sudden death which is usually designated "serous apoplexy." That there are such acute effusions, which may quickly destroy life by paralyzing the brain, can certainly, in the present state of our knowledge, not be denied; but the diagnosis of this mode of death is just as uncertain on the dead body as on the dying patient, for the serum which is found in the arachnoid sac, may be a chronic accumulation that has existed there for a long time, just like that which is contained in the ventricles, or in the tissue of the pia mater, or that which produces œdema of the brain itself. Moreover, the coexistent congestion of the membranes of the brain is usually but slight. And lastly, there are, for the most part, in such cases, various other morbid affections elsewhere, by which the sudden death can be otherwise

explained. I shall have occasion to make some further remarks on this subject at another more suitable place.

Not unfrequently the quantity of this serum is uncommonly small, and the surfaces of the arachnoid appear to be without moisture. This is the case in marked enlargement of the brain, especially in hypertrophy.

THE PIA MATER. (THE CHOROID COAT.)

The intimate relation subsisting between the pia mater and the brain, and the frequent co-existence of disease in the latter with that of the former, render the affections of the pia mater those of the greatest importance. In accordance with what has been said of the arachnoid, and in opposition to the general relations of subserous tissue to serous membranes, the most important processes that occur in this situation, viz., those attended with exudation, greatly preponderate in the tissue of the pia mater.

§ 1. *Diseases of Texture.*

1. *Congestion and its consequences:—Hemorrhage.*—There is no question that congestion of the pia mater (commonly called congestion of the membranes, or inner membranes of the brain) is a very frequent occurrence; and we have already (p. 328) arrived at the same conclusion from our observations on the arachnoid. Yet, on the whole, if we except the “post-mortem” congestion of the pia mater covering the posterior lobes of the cerebrum, any considerable degree of congestion is far less commonly met with in the dead subject than is usually supposed; and there is, perhaps, no respect in which moderation in estimating appearances needs so much to be impressed upon the unpractised observer as in regard to the quantity of blood contained in the vessels of the pia mater: as a general rule, a very moderate injection of these vessels is erroneously looked upon as congestion.

The marked congestions which are met with in the brain and its membranes in very delicate children form an exception to this rule. Much interest attaches to these instances, from their being associated with more or less striking general plethora in children who are usually emaciated.

The congestions are, in general, active, or mechanical, *i.e.*

resulting from disease of the heart, or obstruction in the lungs: sometimes they are passive. They are generally combined with a corresponding degree of congestion of the brain; and sometimes they destroy life, either of themselves, as vascular apoplexy, or by causing an effusion of serum into the tissue of the pia mater and substance of the brain.

The terminations and consequences of congestion vary according to the frequency and the duration of their cause. They consist of thickening and condensation (increase of volume) of the pia mater and arachnoid, of permanent infiltration of the former, and a varicose condition of its vessels. Such a state of the inner membranes is well marked after the congestions which are produced by continued and forced exertion of the mind, or by repeated intoxication, especially with alcoholic drinks. Congestions from the latter cause leave behind them an extremely varicose state of the vessels.

The (mechanical) congestions, infiltrations, and thickenings which the pia mater suffers when atrophy of the brain has formed a vacuum within the skull, also require particular notice in this place.

Spontaneous hemorrhages into the tissue of the pia mater (apoplexy of the vascular coat), though they rarely take place in adults, are frequently met with in new-born children and in the delicate period of childhood. In the latter, the part which mostly suffers from hemorrhage is the pia mater at the base of the brain. Cases of this kind must be distinguished from those in which the pia mater is infiltrated with the blood that escapes from an apoplectic spot, whether peripheral or deeply seated. Except in some rare instances, in which a large vessel, or an aneurism of one of the large arteries is ruptured, the source of the bleeding is the fine vessels of the pia mater. Hemorrhages which result from the skull being shattered, or otherwise injured, are mostly accompanied with bruising and hemorrhage on the surface of the brain.

2. *Oedema of the pia mater.*—The infiltration of the tissue of the pia mater with serum, which I have just brought forward as one result of congestion, constitutes oedema of the membrane. It is most commonly chronic: it may be combined with the other changes which have been enumerated as consequences of repeated and continued congestion; and it may

advance till the pia mater measures several lines in thickness, and the serum pours forth in large quantity, when the membrane is cut or torn off. This is especially the case in atrophy of the brain. The infiltrated pia mater may be easily separated in large pieces from the brain.

Œdema generally involves the entire pia mater, but it reaches by far its greatest amount over the convexity of the cerebral hemispheres. It may affect merely a very small section of the membrane; and it is thus strictly local when only a part of the brain is atrophied: when the wasting is limited to a few of the convolutions, the œdematous pia mater hangs over them like a loose bag.

In those situations where the cerebral arachnoid is stretched separately and like a bridge over certain parts of the brain, most of the serum is poured out in the free space between it and the pia mater.

The discrimination of an acute œdema, as ever proving the fatal result of an acute congestion of the membranes, is attended with difficulties of precisely the same nature as those which surround the question about the existence of such a disease as serous apoplexy. Œdema of the pia mater is associated with that disease.

3. *Inflammation.*—Inflammation of the pia mater (true meningitis) is the most important of the inflammatory affections of the membranes of the brain. In its essence it is inflammation of a loose areolar tissue. It is impossible to depict its general features without distinguishing two totally different forms of the disease.

a. The first form.

a. Its product is, in general, a yellow or yellowish green, fibrinous, or purulent exudation into the tissue of the pia mater. This product is effused, according to the circumstances of the case, sometimes at separate spots, as between some of the convolutions, or along the course of the larger venous trunks of the pia mater, while the membrane itself is elsewhere infiltrated with an opaque grayish serum: at other times the exudation is made up of flakes of fibrin, and is diluted with a considerable quantity of serum; it is of a grayish yellow, or variegated greenish colour, and pervades the pia mater uniformly; or it may contain but little

serum, and be pure fibrin, or pus, diffused in large quantity through the pia mater and its prolongations between the convolutions. In the last case the membrane is manifestly increased in thickness, and may be easily separated from the brain, sometimes without injury, but at other times not without scaling off the surface of the brain with it. It may also be easily torn.

β. In this form the disease usually extends over the convexity of the hemispheres, and as it approaches the base of the brain, diminishes in intensity. It rarely occurs at the base of the brain at all.

γ. The individuals who present this form of disease, are in the youthful period, the bloom of life; they are usually strong, at any rate they show no trace of the tubercular dyscrasia.

δ. The disease is usually unaccompanied with (acute) hydrocephalus; at least the exudations found in the ventricles are mostly slight: so also softening of the stomach does not ordinarily result from it.

ε. Except at its periphery, the brain is unaltered by the disease.

This form of meningitis is very frequently a primary and idiopathic disease; at times it is met with frequently, and according to Forget and others, is even an epidemic: and further, it is the usual result of concussion of the brain. Sometimes it is a secondary affection, and as such, it succeeds other inflammations, extensive exudations on serous membranes, for instance, pneumonia, &c., or it is induced by the contiguity of the membrane to circumscribed inflammation going on in the dura mater and cranial bones, by phlebitis of the venous trunks of the pia mater, or of the sinuses of the dura mater, by the advance of inflammation or abscess of the brain, and so on; or, lastly, it may be excited by the irritation which adventitious growths of various kinds produce within the cranium.

It usually, as I have already pointed out, spreads over a large superficial area, and is sometimes accompanied with inflammation of the membranes of the spinal cord: even when the inflammation has advanced from some other tissue merely to circumscribed spots of the pia mater, it usually spreads out very rapidly into an extensive (general) meningitis. To this, however, there are occasional exceptions; for inflammation and even suppuration sometimes continue to be limited to their

original site; as, for instance, is sometimes the case with the inflammation and suppuration dependent on caries of the skull.

The inflammation is always acute, and more acute in proportion to its intensity, and to the abundance of the exudation. What is called chronic meningitis is really nothing but the various terminations, and the metamorphoses of the products, of an acute inflammation.

Much as it might have been expected, yet are arachnitis on the one hand, and inflammation of the periphery of the brain on the other, far from being constant accompaniments of inflammation of the pia mater. Exudation on the free surface of the arachnoid very rarely occurs, and it is found only when meningitis reaches its most intense degree: the surface of the brain, on the contrary, is certainly more frequently involved. In some rare cases it may be concluded from the terminations and consequences of the inflammation, that it has extended from the pia mater to the surface of the brain in one direction, and in the other to the arachnoid and dura mater, and even to the bones of the skull.

This form of meningitis is frequently fatal; but it often terminates in resolution. When its products change into a cellular or fibroid tissue, the inflammation leaves the pia mater a thickened, whitish, tough, dense membrane; the arachnoid shares in the thickening, the pia mater acquires unnatural connections with the surface of the brain, the cerebral arachnoid adheres to the dura mater, and at length even the dura mater and the skull unite. In some rare cases of this kind, the surface of the brain and the skull are bound together by a series of successive normal and false membranes. Such terminations of meningitis are frequently found in mental disease, especially in cases of secondary imbecility.

Meningitis terminates in suppuration only when the inflammation is local, and passes to the pia mater from other contiguous structures.

b. The second form.

a. The products of the second form of inflammation of the pia mater, though commonly mixed with yellow or yellowish-green spots of fibrin, consist in greatest part of an opaline, flocculent, albumino-serous, gelatinous, sero-purulent, and usually very abundant exudation, the colour of which is grayish,

sometimes shot with yellow or faint green. The opacity of the infiltrated tissue of the pia mater, and of the arachnoid, is palpable in consequence of the transparency of the point. The first-mentioned fibrinous exudation very often assumes the form of granular, plastic nodules, which become tubercles.

β. It occurs almost exclusively at the base of the brain: as the peculiar product, which was mentioned second, especially accumulates between the hemispheres of the cerebrum on each side, from the optic commissure in front, to the pons, and on over the medulla oblongata behind. In this situation it is deposited amongst the numerous vessels and bands of cellular tissue which pass across the spaces between the pia mater and the bridge-like arachnoid. From thence it may be traced into the fissures of Sylvius, and the longitudinal fissure of the cerebrum, and so on to the convex surface of the hemispheres; for the fibrinous product (that which tends to become tubercle) accumulates along the vascular trunks which run in the fissures, viz.—the arteries and veins of the fissures of Sylvius and corpus callosum, and the latter often appear completely enveloped in the exudation.

γ. From these points the inflammation always extends also to the choroid plexuses and the lining membrane of the ventricles, particularly the lateral ventricles, and there gives rise to the exudation of a similar product, from which a distinct purulent sediment is often deposited: thus it is combined with acute hydrocephalus; and very often it is associated also with softening of the stomach.

δ. The brain is always in a state of (acute) œdema or serous infiltration, and of (hydrocephalic) swelling. (Compare Hydrocephalus, treated of below.) At those parts where the process is most intense, and particularly in the fissures of Sylvius, the cerebral convolutions, especially at their superficial parts, become the seat of red or yellow softening.

ε. The subjects of this form of the disease are mostly children, although it is frequent also at later periods of life. I shall have again to notice that the individuals who are attacked with it are mostly persons of bad constitution, especially of a tubercular dyscrasia, or those in whom tubercle is actually deposited.

This form of meningitis is sometimes primary, sometimes secondary; when attended with tubercular exudation, it is generally secondary, and combined with tuberculosis of other

organs. Frequently also, more frequently than the first form, it comes on secondarily as an attendant on various diseases of the brain, such as adventitious growths, particularly tubercle, inflammation, abscess, softening of the brain, and so on, in broken-down constitutions.

The peculiarity of the product of this meningitis appears therefore to arise from exhaustion of the fibrin of the blood by previous exudations of tubercle, or from *hematosis*, resulting from the influence of some of the above-named diseases, pre-existing in the brain. Both in its quality, and in the condition on which that quality depends, the product is strikingly analogous to the gelatinous pasty products which are furnished by pneumonia under the like circumstances of a defibrinated condition of the mass of the blood, and are attended with considerable hepatization and extensive tuberculosis.

Though convinced that in distinguishing two forms of inflammation of the pia mater, and in my portraiture of them, I have been perfectly true to nature; yet I must say expressly that the disease presents other exceptional characters.

a. Instances occur, on the one hand, of meningitis at the base of the brain, in which the exudation is fibrinous (plastic), and even purulent:

β. And on the other hand, it is by no means rare for meningitis, on the convex surface of the hemispheres, to furnish a tubercular exudation. Isolated spots of inflammation are then found scattered through the pia mater, especially through that part of it which dips between the convolutions, and it appears infiltrated with a yellow granular exudation. The spots of inflammation are very commonly, too, the seat of hemorrhage, and the membrane adjoining the tubercular mass appears quite filled with coagulated blood. The adjacent surface of the brain is generally in a state of red (inflammatory) softening. These processes are, almost without exception, combined with tuberculosis of other organs, especially with tubercle in the brain; and they appear to be analogous to the lobular pneumoniæ which are attended with tubercular exudation—tubercular infiltration of the lungs.

The meningitis which occupies the base of the brain, very often extends into the neurilemma of the cerebral nerves, as they pass off through the inflamed part.

4. *Adventitious Growths*.—Exclusively of growths, which originate in the brain, and implant themselves secondarily, and in part only in the pia mater, this class of disease is restricted in the pia mater to tubercle.

Tuberculosis of the Pia Mater.—It is very frequent, and is, of course, one of the most important of all the tuberculosis. It is met with as a chronic disease, but more frequently it assumes the forms of acute tuberculosis, and of meningitis, with tubercular exudation.

a. *Chronic Tuberculosis*.—In this case the tubercle is found in the form of gray granulations, which, sooner or later, become yellow tubercle. The granules are always grouped or clustered together. They are confined to no particular region. They are constantly combined with tuberculosis of other organs, and they commonly form the starting-point for meningitis and acute tuberculosis of the pia mater. I have never met with complete softening, or suppuration of this form of tubercle.

b. *Acute Tuberculosis*.—Tubercle of this kind appears in the form of the finest granules, scarcely as large as poppy seed; it may be grayish and opaque, or quite clear and pellucid, like a vesicle. More rarely it assumes the form of larger, miliary, and separate granulations. It needs not merely familiarity with their appearance, but also a close search of the pia mater in order to find them. The congestion to which they owe their origin is often no longer discernible on the dead subject; but they remain always in large numbers, and always occupy a large section, and not unfrequently, indeed, the whole cerebral part of the pia mater: while, together with them, and as the product of the same congestion, a considerable quantity of serous, sero-albuminous, and more or less turbid exudation are found at the base of the brain, within and about the circle of Willis.

The base of the brain is the chief seat of this form of tuberculosis: from thence it extends towards and over the hemispheres; it is rare to find the convex surface of the hemispheres the principal seat of its development. With a little attention the granules may be easily discovered at the base of the brain by removing the bridge of arachnoid, but it requires the closest search to detect them in the pia mater covering the convexity of the hemispheres: in this situation

they are clustered in the intervals between the convolutions, and are very often further concealed by a good deal of congestion of the membrane.

The amount of the accompanying (acute) hydrocephalus and cedema of the cerebral substance bears a direct relation to the extent to which this form of tuberculosis is developed. It is most frequent in children and young persons, but it may occur at any period of life. It is very rarely the primary disease, but almost always depends upon some previous tuberculosis, either chronic tuberculosis of the pia mater, tubercle of the brain, or the like disease of the lymphatic system, or lungs. Not unfrequently it forms part of a general acute tuberculosis, which has attacked the most different organs and tissues, either all at once, or quickly one after another.

c. Meningitis, with tubercular exudation, so called *tubercular meningitis*. This is the second form of meningitis with a fibrinous, yellow, granular product, which was described at p. 343. Sometimes it is combined with an acute exudation of gray granular tubercle (acute tuberculosis). Sometimes, also, it appears in the form of isolated spots of inflammation of the pia mater covering the convex surface of the hemispheres (described at p. 345). In both forms it has the same combinations and starting-point as the acute tuberculosis.

It is remarkable that the pia mater of the cerebellum is very rarely the seat of tubercle.

On one occasion, I met with a tumour in the pia mater consisting of a cavernous tissue; it was a specimen of teleangiectasis (splenic nævus, Aftermilz), and was situated at the upper part of the left cerebral hemisphere.

OF THE PROLONGATIONS OF THE ARACHNOID AND PIA MATER WITHIN THE BRAIN.

§ 1. *Diseases of the Choroid Plexuses*.—The choroid plexuses are subject to congestion, opacity, and thickening, and to a varicose state of their vessels; and these changes are mostly observed when the pia mater and arachnoid are in a similar condition. The choroid plexuses share more or less also in the processes of exudation, which arise from meningitis and acute hydrocephalus, and are then opaque, swollen, infil-

trated, and covered with flocculent pseudo-membranous fibrin, or with purulent exudation.

Cysts and *calcareous formations* are the principal adventitious products in the choroid plexuses, and they are frequently met with.

The cysts, vesicles, or, as they are sometimes named, hydatids, of the choroid plexuses, are frequent and well known. Various misconceptions have prevailed as to their nature and cause, and undue importance has been attached to their presence. They have been taken for dilated lymphatic vessels, for enlarged capillary vessels (or terminations of arteries), and for new growths; and their value, in the scale of post-mortem appearances, has been commonly over-estimated. They form bladders, sometimes with very thin, sometimes with pretty thick, vascular walls; they may be loose and pendulous, or filled and tense; they vary in size, equalling a poppy-seed, millet grain, or bean; and when very numerous, they give the choroid plexus the appearance of a bunch of grapes. They occur only in the lateral ventricles, at least none that occur elsewhere are large enough to be detected in making the post-mortem examination with an ordinary amount of care, that is to say, none above the size of millet-seed. They occupy the convex portion of the plexus, especially towards the posterior cornu of the ventricle. They appear to me to be a disorder of the gland-like acini and villous appendages of the choroid plexuses, and, therefore, to bear a close analogy to the cysts, which are so often developed from the Malpighian bodies of the kidneys, especially in consequence of inflammation and Bright's disease.

In young persons they are almost constantly absent; but they are very frequent in those who are advanced in life, and in whom there is hydrocephalus arising from vacuum, or thickening and œdema of the inner membranes of the brain, &c.

These cysts, for the most part, have but one chamber, but they are often divided into compartments by delicate partitions. They generally contain a clear serum, but the fluid they enclose is often turbid, whitish, and like lime-water, and at last there is often whitish or yellowish *bone-sand* in them besides. These concretions incrust the cells, and are analogous to the sand met with in the brain: they are found, too, when there are no cysts, in the texture of the villi of the choroid plexuses.

Tuberculosis.—This is an extremely rare occurrence: even when there is an exuberant production of tubercle in the tissue of the pia mater of the base of the brain, there is very rarely any trace of it in the adjoining choroid plexuses.

Cancer.—This disease, occurring alone in the choroid plexuses is one of the very rarest ever met with. I have seen a medullary degeneration of the choroid plexus of the fourth ventricle.

§ 2. *Of the Lining Membrane of the Ventricles.*—The internal membrane of the ventricles of the brain is composed of a very delicate continuation of the arachnoid and pia mater, and a layer of epithelium. The most frequent and most important diseases to which it is liable, have, from one most striking characteristic which they present, viz. an excessive accumulation of cerebro-spinal fluid, been included together under the title of hydrocephalus.

Although it is true that the presence of an excessive quantity of fluid in the ventricles, and structural disease of their lining membrane, are not essentially characteristic of all cases of hydrocephalus, but are sometimes secondary, and occasioned by disease of the brain, and therefore that all the forms of hydrocephalus do not rightly belong to the present section, yet I prefer treating of them altogether, for two reasons:

(1.) Because the most important of all the forms, viz., acute hydrocephalus, arises from disease of the lining membrane exclusively; and

(2.) Because, in spite of their differences, it has become a prevalent custom to associate them together, both in thought and in description.

Though, for the sake of convenience, I thus disarrange the subject, it will be restored again by referring to each of the forms I am about to describe in the place to which it properly belongs.

1. *Hydrocephalus.*—I would here offer the following general remarks: that, in accordance with what has been already said, by the term hydrocephalus is meant "*Hydrocephalus stricte sic dictus internus*,"—dropsy of the ventricles: and that I retain the usual division into acute and chronic hydrocephalus, as it appears to be that which still possesses the most practical value. The chief seat of hydrocephalus is generally the lateral ventricles,

and they are, for the most part, symmetrically affected. Exceptions will be pointed out in their places.

1. *Acute hydrocephalus*—This is both the most frequent and the most important of the forms of hydrocephalus—the acute dropsy of the ventricles. Anatomy discloses two essentially different forms of it.

a. *The first form.* Its anatomical characters are—

a. The effusion of a fluid which is thin or somewhat thick, of a grayish colour, or grayish yellow tinged with green, and more or less turbid, in proportion to the quantity it contains of plastic matters capable of assuming some of the primary forms of organisation. It is very often found to have separated into two parts—one fluid, and the other of more consistence and deeper colour: it has, in fact, become clear from certain of its elements having fallen to the bottom as a sediment. These elements are usually found in the most dependent part of the lateral ventricle; viz., their posterior cornu. On minute examination of the effusion, its opacity is found to arise from the presence of the elements of a plastic exudation, nucleoli, nuclei, cells at various stages of development, and true pus-cells; and of them the sediment, distinguished by the deeper yellowish or greenish colour which it presents, is, for the most part, composed. But cast off epithelium in course of solution, shreds of the lining membrane of the ventricles, and even shreds of nerve-tubes, are also found in the effusion, and all contribute to its opacity.

In some few cases a more solid exudation is observed besides the fluid effusion; it adheres here and there, especially on the corpora striata and optic thalami, in membranous plastic flakes to the lining membrane.

β. The quantity of the morbid effusion cannot be accurately determined, because of our uncertainty as to the pre-existing or normal quantity of fluid in any particular case. The whole quantity, however, inclusive of that which previously existed, is generally not considerable, and usually does not exceed an ounce; oftentimes it is scarcely half so much. On the other hand, in a few cases in which acute hydrocephalus supervenes upon chronic, (whether the latter be congenital, or have come on early in life,) the quantity of opaque contents of the ventricle

is very considerable, and the greater part of it appears to have been produced by the recent process. The enlargement of the ventricles corresponds to the quantity of their contents, and in ordinary cases is but slight.

γ. The lining membrane of the ventricles becomes opaque, soft, and dissolved, and shreds of it consequently appear in the effusion.

The choroid plexuses become opaque and softened, and are very commonly enveloped in a villous and slightly shreddy layer of grayish, or grayish-yellow exudation.

δ. From this point further changes extend in two different directions, to the cerebral substance, and to the inner membranes at the base of the brain. The affection of the membranes is the more essential part with respect to the nature of the process.

(1.) In the neighbourhood of the ventricles the cerebral substance is percolated with serous fluid — infiltrated — to such a degree, that it seems as it were in a state of watery softening; very often, too, it is streaked or dotted with ecchymoses. The cerebral substance is thus affected wherever it adjoins the lining membrane of the ventricles; but very commonly the fornix and septum are softened to the greatest degree, and the latter is sometimes quite broken down and perforated. From this spot the œdema extends through the whole of the cerebral hemispheres, always, however, diminishing gradually as its distance from the ventricles increases, and always being greatest close to them. Hence the cerebrum swells, and increases in actual volume; its convolutions are forced against the walls of the cranium, and flattened; and in the same manner the cerebellum and pons are depressed and flattened in a marked degree. The inner membranes covering the convex surface of the hemispheres, being involved in the pressure against the cranium, appear bloodless. The cerebral substance also is bloodless and pale; it has a singular dull white appearance, and a peculiar soft and doughy consistence arising from its uniform moistness.

(2.) With the affection of the lining membrane of the ventricles and choroid plexuses, the diseased condition of the inner membranes at the base of the brain, forms one entire disease, not only by continuity, but in essence also. It takes the form

of meningitis, especially of that described at page 343 as the second form of meningitis; or else it appears as acute tuberculosis of the pia mater at the base of the brain. In speaking of the serious character of these processes, I have already grounded it on their extension to the lining of the ventricles, that is, to their combination with acute hydrocephalus.

b. The second form. Its anatomical characters.

a. Effusion of a clear, colourless, serous fluid into the ventricles; sometimes it is slightly turbid, from being mixed with shreds of the lining membrane and of cerebral matter.

β. The effusion varies in quantity, being sometimes slight, but more frequently considerable, amounting even to six ounces.

γ. The cerebral substance around the ventricles is generally in a state of watery softening, in which the rest of the cerebral mass shares, only in a less degree, the change in it not exceeding ordinary œdema. The whole brain presents the same swelling, and the same general condition as have been described of the first form, but, generally, even to a more marked extent. The cerebral substance surrounding the ventricles and the lining membrane, may sometimes be found in the dead subject in a normal or nearly normal condition; but this happens only in some extremely rare cases, in which the disease is known to have run an acute course.

The most remarkable, and one of the most important of the post-mortem appearances, in both the principal forms of acute hydrocephalus, is this almost constant softening, or, as it is called, maceration of the cerebral substance about the ventricles. Before proceeding to any general remarks, some notice of the nature and import of this appearance is indispensable.

In so far as regards anatomical disorganisation, I hold it to be in itself no very essential part of the disease; it is, however, certainly very important, and perhaps even more so than the effusion into the ventricle itself. For first, it involves cerebral substance, and secondly, it attacks that substance in a very acute manner, and rapidly produces disorganisation of it. It is, in fact, nothing more than an acute œdema of the highly delicate and easily injured texture of the brain, and the equally delicate lining membrane of the ventricles; but so rapid, occasionally, is its progress, and to such degrees does it

advance, that it gives rise, for the most part, to countless lesions of continuity, and thus, in the form of softening, disorganizes the brain and destroys life: if it should advance more slowly, or to a less degree, it may very often continue a long time without marked symptoms.

The mode of origin, and the import of this œdema, will be more distinctly understood from the following particulars:

(1.) It corresponds entirely to the œdema which surrounds every spot of inflammation, and to that which ensues upon acute congestions.

(2.) And further, it is in my opinion worthy of remark, that if an effusion take place so rapidly that room cannot at once be obtained for it in the ventricles, by displacement of the brain, the resistance from within is so great as to hold, or press back, the exudation, and a portion of that which should be exuded from the lining membrane of the ventricle, is poured into its tissue, and into the adjoining part of the brain. The greater the intensity of the process, and the quantity of its products, the sooner does infiltration ensue, and break down the textures; and it will the more readily take place, if the brain have been œdematous before, or the cerebral mass around the ventricles have been distended by a pre-existing effusion.

(3.) In the first of the two forms of hydrocephalus, especially in that with which true meningitis is combined, the serous exudation which gives rise to softening of the cerebral substance around the ventricles is sure to contain a portion of coagulable or plastic materials, capable of assuming a primary organic form: in the second it is entirely, or almost entirely, composed of pure serum. This accounts for the circumstance that, in many cases, the macerated cerebral substance, when minutely examined, is found to contain the so-called exudation-corpuscles, exudation-cells, nucleated and primary cells (pus-cells), while in other cases these are entirely wanting. (Gluge.)

This state of the brain, then, may be suitably classed, as has been done already, with the termination in softening, and may be named white softening, hydrocephalic softening. I shall have some further remarks to offer upon it when treating of œdema, especially in the article on Softening of the Brain.

This white softening of the cerebral substance is sometimes accompanied with yellow softening, more particularly when

the case is one of the first form of hydrocephalus, and combined with meningitis.

Moreover, I have alluded above to the softened cerebral substance being sprinkled or streaked, as it were, with red ecchymoses: both forms of the disease present this feature, but it is more common in the first form. It arises from the laceration of the delicate vessels, which are torn when the cerebral texture is broken down; but there is very often far less of it than the degree of disorganisation would lead us to expect. The question which this suggests, admits as yet of no other solution than that the simultaneous swelling of the whole brain so obstructs, and precludes the injection of, the cerebral vessels, that those which are torn are empty.

With respect to the nature of acute hydrocephalus, an inquiry which has led to so much discussion, that of the *first form* of the disease is perfectly clear: it is either an extension of meningitis of the base to the ependyma of the ventricles,—of a meningitis attended with an exudation that contains less than the average of plastic material, that bears traces of a faulty constitution of the blood, and that, in its fibrinous portion, is very often tuberculous; or it consists of a supplemental, and, for the most part, serous exudation, accompanying an acute deposition of tubercle in the pia mater, at the base of the brain. This form of acute hydrocephalus, therefore, is either actual inflammation, or an exudative process having a general connection with it. Although I cannot coincide in the opinion of several French observers, who think that acute hydrocephalus is never anything but meningitis,—by which term acute tuberculosis is also meant,—yet I so far agree with them as to believe, that in the great majority of cases such is the fact, and that the meningitis is very commonly of a tuberculous character.

This form of hydrocephalus occurs both as a primary and substantive, and as a secondary affection. When secondary, it attends the diseases of the brain which have been mentioned already, at p. 344; viz., inflammation, abscess, and yellow softening, adventitious growths within the skull in general, but, more than all, with tubercle of the brain: with that disease it associates itself, either in the form of meningitis with tuberculous exudation, or in that of acute tuberculosis. It is very frequently the means by which those diseases of the brain

destroy life. The hydrocephalus which originates with tubercular meningitis, or with acute tuberculosis, is very rarely a primary disease, but supervenes upon some previously existing tuberculosis, upon that in the brain particularly, as well as that in the glands or in the lungs: when connected with acute tuberculosis, it forms one of the many local parts of the general disease. (Compare p. 347.)

The subjects of it are, for the most part, children; but adults, and even persons advanced in life, suffer from the secondary form, especially when it is a process connected with tubercle.

The *second form*, though an acute hydrocephalus, cannot be admitted to be inflammatory: it bears, in fact, none of the characters which mark inflammatory states or products. It arises from congestions of various kinds; such as are connected with the development of the brain in childhood, or those produced by chronic eruptions on the scalp, by the irritation of morbid growths within the skull, &c. These congestions are analogous to those from which acute dropsies of many of the serous and synovial membranes result,—dropsy, for instance, of the tunica vaginalis testis, and the acute œdemas. It may be occasioned, too, by the congestions which follow concussion of the brain, or mechanical obstructions, such as disease of the heart, rickets of the thorax, impermeability of the lungs in tuberculosis and phthisis, chronic catarrh of the bronchi, chronic pneumonia, &c. The result of these congestions is an excessive effusion of serum, first from an apparatus specially adapted for that purpose, viz. the lining membrane of the ventricles, and then into the brain itself.

These effusions, if the process which gives rise to them be very intense, destroy life at once, upon their first occurrence; otherwise they are fatal only after being several times repeated. Hence it is that the quantity of fluid found in the ventricle varies so much: the larger accumulations, those which amount to as much as six ounces, are apparently the sum of several smaller effusions, occasionally repeated. The enlargement of the ventricles corresponds to the quantity of serum within them; and the skull enlarges in an equal degree until the sutures are closed.

This form of hydrocephalus, then, not unfrequently runs a

protracted, subacute course; and it tends the more to do so, in proportion as the several exudative processes are slight in degree, and as the skull retains more of its early elasticity. And further, the less distinguishable the several exudations are from one another, the more this form is allied to chronic hydrocephalus.

It is sometimes a primary and substantive disease, sometimes a secondary. When primary, it is in childhood, like chronic hydrocephalus, remarkable for its combinations, of which I have to speak hereafter; and for being intimately connected with a deeply-lodged anomaly of the general vegetative processes. When secondary, it is frequently occasioned by various diseases of the brain, as inflammation, abscess, and by morbid growths in the skull.

Considered apart from chronic hydrocephalus, which stands in close proximity to its subacute variety, it is certainly, on the whole, more rare in childhood than the first form; but then it may occur much earlier, being met with in the first year of life, and doubtless, also, in the fœtus. Moreover, it is not very rare at any later period of life, up to old age, for it is occasioned by mechanical congestions in the course of various chronic adynamic diseases, which are attended with a dropsical crisis of the blood.

Both forms of acute hydrocephalus are attended by certain combinations, some of which are common to both, while others are peculiar to one of them. They are partly constant and essential, and partly neither constant nor essential.

The first form is, in the great majority of cases, combined with a tuberculous diathesis, and the local tubercloses, mentioned at p. 347: these constitute the fundamental anomaly.

The second form combines with it several abnormal conditions, especially in children; and very often all the disorders enumerated below occur together, and form one complex morbid state, that manifests a thoroughly depraved working of the vegetative processes. They are—

- (1.) Hypertrophy of the whole system of lymphatic glands, and of the follicular apparatus of the intestinal mucous membrane.
- (2.) Arrested decay or involution of the thymus gland.
- (3.) Chronic catarrhs, especially of the bronchi.
- (4.) Rickets and its attendants.

One coincidence, which deserves special attention amongst these combinations, is that of hydrocephalus with hypertrophy of the brain. The latter is well known to be very commonly associated with general rickets; but the former is so constantly found to be connected with rickets of the thorax, that Engel has given the name of hydrocephalic to that particular distortion of the chest.

A very common and essential combination with both forms of the disease, and one with which the fatal result is frequently connected, is softening of the stomach.

The following are unessential, and, to a certain extent, merely accidental combinations: hypostatic congestions of the lungs, lobular pneumonias, slight pleuritic exudations, enlargement of the liver, &c. Intussusceptions are very frequently met with in the intestines; but, although Abercrombie attributes them to the same cause as the vomiting which occurs in the course of the disease, they have certainly not existed for any length of time, and must rather have arisen during the agony; for they present no trace of any congestion or swelling of the bowels from the strangulation of those vessels of the mesentery, which are invaginated with the bowel.

Terminations.—The great fatality of acute hydrocephalus is well known, and may be accounted for. The first of the two forms, when a tubercular process, is undoubtedly always fatal; but when it is a simple meningitis, it may, as well as the second form, be outlived and cured, provided it be moderate in degree, and especially if the brain have escaped complete destruction by white softening.

This termination, in a more or less complete cure, may be reduced to the following particulars:

(1.) The products of the process may be entirely reabsorbed, and the brain be restored to its natural consistence, size, and figure.

(2.) A part of the effused fluid, or the whole of it, may remain in the ventricles, and both they and the skull may be permanently enlarged. This can only be conceived to take place in the child just before the skull is completely ossified. The acute hydrocephalus thus becomes a chronic accumulation, which is capable even of further gradual increase.

(3.) In that case, the lining membrane of the ventricles

very often remains thickened in various forms and degrees. The quantity and density of its tissue are increased, and the plastic exudations remaining upon its surface become converted into a cellular or fibroid tissue, and covered with a layer of tessellated epithelium; thus both contribute to the thickening of the wall of the ventricle. The new tissue assumes various forms, similar to the false membranes which occur on serous surfaces. As its presence on so delicate a substratum as the ependyma is of some interest, and as it may be the means of leading to a more accurate examination of the cases in question, I will give a more detailed description of it.

a. The lining membrane sometimes appears covered with a granular film, like the finest sand, which has a transparent crystalline, or an opaque, grayish white, appearance, and can be detected only by looking carefully while the light falls favorably upon it. It may occasionally be seen at every part of the lateral, third or fourth ventricles, but it is generally most developed at particular spots, as the corpus striatum, and tænia semicircularis, and especially in the anterior cornu of the lateral ventricle.

β. More rarely it forms coarser granulations, which are then more prominent, and in time become nodules attached by a pedicle. These granulations, more particularly, are analogous to the false growths of the same kind, which occur on other serous membranes, and to the Pacchionian bodies on the arachnoid.

γ. Sometimes the new tissue is smooth, membranous, and superficially attached, and forms separate, round, white, opaque, islands, or "plaques," which are not unfrequently thinner in their middle, and, as it were, perforated (gefenstert, latticed): this form is analogous to the tendinous spots.

δ. At other times the tissue is similar in its character, but instead of forming separate islands, it is continuous, and the whole seems knitted or areolar, and forms an adherent network of false membrane, which may generally be easily raised from the surface.

ε. Or, lastly, it forms false membranes of considerable and nearly uniform thickness, which are, for the most part, intimately united with the lining membrane.

In these last sometimes bony concretions are developed.

In some very rare cases of chronic hydrocephalus in children, especially of congenital but advancing hydrocephalus, in which, also, the thickenings just-described exist, a peculiar appearance is met with on the walls of the ventricle. The cerebral substance protrudes into the ventricle at various spots, probably those where the ependyma is relatively thinner, and forms rounded, smooth bosses, with broad bases, as large as hempseed or peas. I have had two opportunities of observing this peculiarity.

(4.) Does it happen, as Otto, I believe, first asserted, that hydrocephalus (of course I mean the second form, that which is allied to chronic hydrocephalus), is ever cured by the super-vention of hypertrophy of the brain? I have already (p. 357) considered the combination of hydrocephalus and hypertrophy of the brain, which is occasioned by rickets: I believe, further, that the hydrocephalus (the hydrocephalic process) may itself sometimes give the first impulse to hypertrophy of the brain: but that any compensation for, or cure of, hydrocephalus is effected by hypertrophy, appears to be altogether problematical. Such an opinion is founded upon the fact, that in some large skulls of hydrocephalic shape, the brain exceeds the normal size and weight. But, I believe, that these are cases in which the hypertrophy having taken place in childhood, has continued ever since; and that belief is confirmed by the resemblance, in shape, which subsists between the skull in hypertrophy and the hydrocephalic skull, as well as by the difficulty which the similarity in the symptoms of hypertrophy and hydrocephalus imposes, upon our determining positively what disease of the brain did exist in childhood. So far as I am aware, the morbid increase in the volume of the brain in hydrocephalus, as well as its normal growth, takes place always in the neighbourhood of the enlarged ventricles; it is a peripheral deposition around them: and the skull goes on increasing in size to whatever extent its closure may be prevented by the hydrocephalus.

B. *Chronic hydrocephalus* may be subdivided into congenital hydrocephalus, and that which commences at various periods of extra-uterine life: besides these, there is a third and entirely different form, hydrocephalus ex vacuo. The distinction between the first two forms is not made from any essential difference between them, for in the most important particular, viz., their

cause, they are undoubtedly alike; but congenital hydrocephalus presents such very marked peculiarities that the distinction appears justifiable.

The general anatomical characters of chronic hydrocephalus are a large accumulation in the ventricles of clear and colourless serum, which contains very little animal matter, and a thickening and toughness of their lining membrane, for the most part to a considerable degree.

a. Chronic hydrocephalus, commencing after birth.—This is either a termination or continuation of acute hydrocephalus, especially of the second form of it; or else it is chronic from the first. The symptoms during life in the latter case were not such as to indicate the existence of any acute disease of the brain; they were rather those of a long-continued disease which occasionally underwent exacerbations.

This form of hydrocephalus may occur at any period of life; but it is most frequent in the first years, and then attains its most advanced degree. The quantity of serum accumulated varies considerably, and depends upon the duration of the disease, and especially on the circumstances of the skull being closed, or not, when it commenced, and whether its origin date from early childhood. In the first case it amounts to two or four ounces; while in children, and in adults who have had the disease since childhood, it may be as much as six, eight, or ten ounces, or even more. In children the skull increases in volume in proportion to the quantity of serum and the enlargement of the ventricles, and, at the same time, acquires the well-known hydrocephalic form, which so often continues throughout the remainder of life. This hydrocephalus then precisely resembles the congenital disease, and might in any case be taken for it, were there no certainty that it had come on since birth. The anatomical description of it agrees entirely with that of the congenital disease.

In respect to its causes, and the mode of its development, it essentially corresponds with the second form of acute hydrocephalus; oftentimes it is a primary and substantive disease, but very frequently it is secondary and symptomatic. Thus in the child as well as in the adult, it arises as a primary disease from repeated and continued active congestions, such as, in the former, occur during growth, and in the latter, more

frequently from excessive exertions of mind, repeated intoxication, &c. As a secondary affection, it is a consequence of different diseases of the brain, particularly of adventitious growths within the cranium; or it comes on in the course of chronic diseases of the lungs, &c. Some growths are so situated that their pressure renders a sinus, particularly the straight sinus, impervious, and thus gives an especial occasion to chronic hydrocephalus (Barrier).

What has been said of the combinations of the second form of acute hydrocephalus applies to the chronic disease also. When thus combined, it runs a lingering course, and has the character of a constitutional affection.

Terminations.—*a.* Two circumstances may interfere with a complete cure of the disease by the reabsorption of the fluid, the great quantity accumulated, and the extent to which the skull is correspondingly enlarged. The only real cure is a cessation of the process, and then the quantity of this fluid continues undiminished throughout life. The question, as to a cure being brought about by means of hypertrophy of the brain, has been already met at p. 359.

β. The disease may terminate fatally—

(1.) By pressure, and consequent palsy of the brain, after having reached a certain degree, and having sometimes, in adults, occasioned absorption of the inner table of the skull;

(2.) By the supervention of, or advance of the process to, a considerable acute exudation into the substance of the brain, by œdema of the brain, and hydrocephalic softening;

(3.) By an attack of acute hydrocephalus and meningitis.

b. Congenital hydrocephalus.—This form of hydrocephalus is one of an eminently chronic character; it exists at birth, and usually has then already made considerable progress; but, if not, it soon increases, and, by the extraordinary size which it attains, and the amount of deformity it produces, it constitutes the most striking example of the disease.

It is then distinguished by the large quantity of serum which the ventricles contain, and by the extent to which they and the skull are enlarged. Those cases in which no monstrosity of the brain coexists, may be portrayed as follows: The quantity of serum contained in the ventricles amounts to several pounds, 6—10, or even more: the ventricles are expanded into large

elliptical cavities, or membranous sacs; and their ependyma or lining membrane is generally much thickened. The cerebral mass around the ventricles, especially towards the top of the head, is attenuated, and sometimes measures scarcely a line in thickness: it may be even so reduced as to be but a just perceptible layer covering the membrane. In one case, which is preserved in the Vienna Museum, it is broken quite through, at the upper part of the hemispheres, by the thickened membranous walls of the ventricles, and has receded from them to a considerable extent. Internally and inferiorly, the serum by its pressure flattens the corpora striata and optic thalami, and passing into the third ventricle, it forces those bodies asunder also; the corpora quadrigemina become smoothed, the commissures stretched, and the gray commissure very commonly wasted; the pillars of the fornix are forced apart, and, with the septum, driven up against the corpus callosum; they are also either all much raised, or the septum is enlarged, very much thinner than natural, and broken through in one or more places of various size. The floor of the third ventricle is thin and transparent; the cerebellum is flattened from above: the pons is flat and spread abroad; the crura cerebri are separated; the pituitary gland is flat, or even concave, and wasted from pressure. The size of the cerebrum is greatly disproportioned to that of the cerebellum, the parts at the base of the brain, and the nerves. The surface of the cerebrum is flat, its convolutions are but just indicated, and could not be recognised; and all the membranes of the brain are unusually delicate and thin. The head is quite remarkable for its size and its deformity. (Compare p. 213.)

Congenital hydrocephalus is far from constantly agreeing with this picture: on the one hand, the quantity of serum, and the enlargement of the ventricles and skull, may be less than has been stated, and may indeed only just exceed the normal standard: while, on the other hand, under certain conditions, the development of the brain may be faulty, even to monstrosity.

The mode of origin, or pathogenesis, of congenital hydrocephalus differs most probably in no essential particular from that of the chronic hydrocephalus which commences in the extra-uterine period of life. It may come on in the fœtus as acute hydrocephalus, or appear originally in the chronic form.

The general arrangement of the skull of the fœtus, and the manner in which the cerebrum itself is developed, are both highly favorable to an excessive accumulation of serum. And I believe, that the really essential part of congenital hydrocephalus, that which arrests the development of the brain, is the affection of the ependyma; that, in proportion to the degree to which the hydrocephalus has advanced, and according to the period of foetal life at which it commenced, it does, in various manner, and to different extent, arrest the development of the brain, and occasion monstrosity of it; and so far contains the ground of its alliance with hemicephalus, hydrencephalocele, singleness of the cerebrum (cyclopia), &c.

What has been said of the combinations of acquired chronic hydrocephalus, describes those of the congenital disease also. A congenital dwarfish growth sometimes takes the place of rickets.

Terminations.—The hydrocephalus of the fœtus, even when it has reached a considerable extent, is not unfrequently inherited by the child, the youth, and even the adult. During the intervals in which the disease is quiescent, the brain grows, and acquires its normal volume, and the skull, continually advancing over it, at length closes. In some rare cases, growth passes beyond its normal bounds into hypertrophy; but with regard to the cure of hydrocephalus by hypertrophy, what has been said at p. 359, may be applied in this place.

The disease sometimes proves fatal by the pressure which the continual accumulation of water exerts upon the brain. Frequently, too, acute inflammation of the ependyma, and meningitis arise in its course. I have, moreover, seen it terminate by rupture of the brain and dura mater, and extravasation of the serum of the ventricle beneath the pericranium and adjoining aponeurosis.

Finally, considerable importance attaches to the hemorrhages which take place in the course of the disease: they are met with both in the arachnoid sac and also, and more especially, in the dilated ventricle. They are remarkable for the length of time during which they are borne, as is attested by the metamorphoses of the extravasation. The way is most probably prepared for their occurrence by the stretching

of the vessels of the membranes that cover the brain and line the ventricles, during the distension of the latter; and it is by the final rupture of those vessels that they are actually produced.

c. Hydrocephalus occasioned by a vacuum within the skull.—

When an empty space is formed within the skull by a reduction of the volume of the brain, it is filled up (as already pointed out, pp. 329 and 340,) by an increase of the volume of the inner membranes of the brain, and especially by an extraordinary exhalation of serum into the tissue of the pia mater, the sac of the arachnoid, and the internal cavities of the brain, more particularly the lateral ventricles. These changes result from the congestion of the vessels which the vacuum produces. The most common instance of effusions of this kind into the ventricles, is that which occurs when the brain is atrophied in old age; a condition which has obtained the title of hydrocephalus senilis. From the process of involution of the brain, which gives rise to the affection in this instance, being so free from complication (*einfach*), from its uniform occurrence in both halves of the brain, and, lastly, from its frequency, it may serve as an example of this species of hydrocephalus. But the same condition is met with also in all cases of premature senility of the brain (*senium præcox cerebri*) and in every spontaneous and primary, as well as in every consecutive atrophy. Examples of the latter kind occur after recovery from repeated attacks of apoplexy, after inflammation of the substance, which has terminated with induration and wasting of the diseased portion, after the closure of an abscess, the healing of a wound attended with loss of substance, &c.

Hydrocephalus is symmetrical, or otherwise, according to circumstances. The quantity of serum contained in the ventricles, and the dimensions to which these cavities are enlarged, are measured by the degree to which the brain is atrophied: the former very commonly equals an ounce and a half, it often amounts to 2 or 4, and may reach even 6 ounces, or more. As the quantity of serum increases, it accumulates in greater proportion in the dilated third ventricle, and produces especial attenuation of the gray commissure, the pillars of the fornix, and the septum ventriculorum: the septum may even be more or less perforated.

The serum in the ventricles, like that contained in the sac of the arachnoid, and that infiltrated through the tissue of the pia mater, is remarkably clear.

As the membranes at the periphery of the brain increase in volume, so also does the lining membrane of the ventricles become thicker than natural; and it often bears on its surface some analogue of the Pacchionian corpuscles of the arachnoid; for the membrane is covered over with fine granules, which are either clear like crystals, or opaque and white. This thickening is the principal cause of the resistance which is experienced in slitting up the walls of the ventricles.

Serous cysts on the choroid plexuses are frequently found in hydrocephalus senilis.

Though, from what has been said, it will be perceived, that in none of these cases is the watery effusion the essential disease, yet the false meaning which is often attached to it, especially in senile hydrocephalus, renders it necessary to remark expressly, that the whole gravity of the case rests with the disease of the brain to which the effusion is owing. And so, too, the symptoms during life, and the usual mode of death, are to be comprehended and estimated by the same rule; the latter, for instance, is not to be sought in the effusion, but is to be looked upon as the final consequence of an atrophy of the brain, which has arrived at its relative maximum.

All these forms of hydrocephalus, as I have already partly explained, combine with one another. Thus the acute disease not unfrequently supervenes upon the chronic, whether the latter be the congenital or the acquired; the hydrocephalus ex vacuo may associate itself with any of the other chronic forms.

The chief seat of all the forms of hydrocephalus, as I remarked at the commencement, is the lateral ventricles; when the effusions are large, they always advance into the third ventricle, but the fourth is even then involved in a very subordinate degree, and may not be involved at all.

An accumulation of serum in the ventricle of the septum, is far more frequently met with than is generally supposed, especially in cases of chronic hydrocephalus; but it is decidedly rare for the accumulation to be at all great, and for the cavity to be very considerably enlarged.

The enlargement of the lateral ventricles is chiefly confined to their body, and the anterior and posterior horns; that of the inferior horn is usually less in proportion.

As a general rule, hydrocephalus is a symmetrical disease; but in some of the chronic forms the dilatation predominates on one side, and in the hydrocephalus ex vacuo it is sometimes entirely confined to one side. Slighter degrees of inequality on the two sides not unfrequently exist in senile hydrocephalus, especially in the instance of atrophy of the brain following the closure of an apoplectic cyst.

2. *Adventitious growths.*

a. *Cellular and fibroid formations* have already been mentioned to occur as inflammatory products on the free surface of the ependyma, and to occasion the increase in the volume of the membrane itself (p. 357). A few cases have been noticed in which flat, or rounded, or irregular nodulated tumours of fibroid structure were developed in the lining membrane, independently, so far as could be traced, of any inflammatory process. Sometimes free bodies of a similar fibroid texture, and of fibro-cartilaginous appearance, are found in the ventricles; they are, most probably, merely tumours of the same kind which have been loosened from the ependyma, or the pedicle of which has been broken.

b. *A production of bone* takes place occasionally in the more bulky growths of the kind just described. In some few cases I have noticed here and there traces of a formation of bone in the fibroid products of inflammation attached to the ependyma; and in one well marked case delicate plates of bone were formed so extensively in a knitted (areolar) false membrane of that kind, that the lining membrane seemed to be incrustated with them.

c. *Tuberculosis.*—I have never met with tubercle on the lining membrane of the ventricles. The exceptional character, which the membrane assumes in this particular from other serous membranes to which it is allied, can as yet only be accounted for with any probability, by supposing that in the process of softening, which goes on in acute tubercular exudations in this situation, the delicate structure of the lining membrane is destroyed too soon for the coagulation of the fluid blastema of tubercle to take place.

d. *Morbid growths of cancerous nature, or of a nature allied*

to cancer, though they certainly do occur upon and within the ependyma, are extremely unfrequent in that structure, as well as in the choroid plexuses. I met with a very remarkable case of encephaloid degeneration diffused over the lining membrane of the cerebral ventricles, and encephaloid cancer of the tuber cinereum in a girl of 10 years of age. The lining membrane of the enlarged dropsical ventricles was converted into a tolerably thick, white stratum of medullary disease, which formed round, and conical, nipple-like processes growing in towards the cavity.

e. On one occasion I met with an animal, resembling the *cysticercus*, with a large, moderately-filled bladder (Schwanzblase) attached to it, lying free in the right ventricle of a young person.

3. *Anomalous contents of the ventricles.* As the most important of the unnatural contents of these cavities may be gathered from what has been already said, or from what will yet be mentioned, there needs no special enumeration of them.

The results of chemical examination of the effusions in hydrocephalus, afford but little interest; they have been made without sufficient attention to, and distinction of, the different forms which the disease presents.

SECTION II.—ABNORMAL CONDITIONS OF THE BRAIN.

§ 1. *Deficient and Excessive Development.*—Acephalus, or deficiency of the head, affords an instance in which the brain is entirely wanting. In such a case more or less of the spinal marrow and vertebral column, especially of their upper part, is generally wanting too. And with this deficiency is combined absence of the heart, of great part of the vascular system, of the lungs, and of the principal abdominal organs, so that, while the urinary and genital organs exist, nothing else can be found within the peritoneal sac, except a rudimentary intestinal canal.

In cases allied to this an extremely rudimentary and simple brain is enclosed in a very small cranium, in a mere shapeless, and very small, bony capsule: monstrosity of the face exists also.

Sometimes a part of the brain is wanting. It may be the

whole cerebrum or any large section of it, as the anterior lobes with the organ of smell, the optic thalami and optic nerves, the posterior lobes, the fornix, the septum, the corpus callosum, the cornua ammonis, &c. The skull is then small in proportion to the deficiency, and the face wanting or malformed: or, again, it may be some smaller and less essential part of the brain, as the hippocampus minor, or the gray commissure; or single convolutions, so that the white substance is exposed, &c.

Again, the brain may be generally of small size, though it exists in all its parts; and the skull is diminished to a corresponding extent: but of this state, microcephalus, as well as of several other instances of deficient development of the brain, a further account will be given amongst the anomalies in its form.

There is, besides, one instance of congenital deficiency of more or less of the brain, which I have not put in the same series with those already mentioned, because, to say the least, it is highly probable that it owes its origin to an attack of hydrocephalus at some period (generally a very early period) of foetal life. It is the instance known as an anencephalus, hemicephalus, and also as acrania.

There is much difference in the extent to which different cases of hemicephalus proceed, depending partly on the extent of the previous hydrocephalus, but principally upon the period of foetal life at which the disease of the brain commenced. Sometimes that organ is wholly wanting, and only the membranes are found at the base of the skull, with the cerebral nerves sunk into them: sometimes a few rudiments of the brain exist, particularly those structures which compose its base; while it is covered with a membrane, formed of much-attenuated skin and dura mater, which exhibits traces, more or less distinct, of having been ruptured. The vessels of the inner membranes are generally numerous and gorged, the membranes themselves are filled with extravasated blood, they present a honeycombed arrangement of their structure (which has been compared to hydatids), and contain some grayish-red cerebral substance. The brain itself is unusually vascular and soft, and appears as if it had been macerated. The roof of the skull is almost entirely wanting; for the usually expanded frontal and parietal bones form mere small and slender streaks,

or irregular triangular plates of bone, and are sunk down upon the base; and the broad occipital plate is shrunk to a few rudiments, or severed by wide fissures. A vault may be formed to the skull by these rudiments of the bones, but it is very low, and divided by a wide fissure from before backwards. The bones at the base, if they are not divided also, are small like the occipital bone, but very thick and coarse.

In other cases, only a small part of the cerebrum is destroyed; and, as the greater part of the brain remains, the cavity of the cranium is proportionally capacious, and the deficiency of bone is confined to its uppermost part.

Hemicephalus is allied to a certain stage of hydrocephalus. Within a skull of normal size or enlarged, but which is closed, there exist no cerebral hemispheres, but a sac, surrounded with the cerebral membranes, and filled with serum, while the base of the brain lies at the lower part of the skull, more or less rudimentary and misshapen. Such a case exhibits clearly the alliance which subsists between hemicephalus and hydrocephalus, and the foundation of the former in the latter; but the combination of hemicephalus with encephalocele, that is, its origin from hydrencephalocele, exhibits it more clearly still. In this instance of hemicephalus, a part or even the whole of the brain, destroyed in the manner above described, lies outside the skull; the cranial vault is split along the mesial line by a greater or less fissure, and is low in every case, but it is sometimes quite sunken to the base.

But further, we have an opportunity sometimes of demonstrating this cause of hemicephalus, by direct observation at the time of its occurrence. The skull of a fœtus, at such a time, is found distended and hydrocephalic, and at the vertex a slough is seen, produced by the pressure and stretching.

Lastly, hemicephalus is very frequently combined with the same instances of arrested development as the higher degrees of congenital hydrocephalus. It is often accompanied, too, by fissure of the vertebral column (*spina bifida*): when the occipital bone is split completely through, the cervical vertebræ are nearly always fissured also.

When the brain is developed in excess, it becomes more or less completely double. It is very rarely found that any one part is double while the remainder of the brain is single;

though such is sometimes the case, with the greater for instance. The cerebrum and cerebellum show an unusual number of lobes, and thus appear to be in excess.

§ 2. *Deviations of Form.*—The form of the brain corresponds to that of the skull, but anomalously principally in the cerebrum. In the first place, subject to variations, in respect to its length, its height: in the next place, some of the larger, the anterior or posterior lobes, for instance, may come short of, their normal development: the form of the brain may be unsymmetrical, in consequence of inequality of size generally, or of a difference of diameter, or in consequence of a change of relation to the horizontal or in the vertical direction, &c. its form varies in respect to the stronger or flatter of the separate lobes, and to the number and symmetry of the convolutions of the cerebrum, the cerebellum.

Alterations of shape, similar to these congenital occur also, as results of disease of the brain: the instances are those in which the symmetry of the brain is deranged, by an increase or diminution in the size of the whole, or of part of one side, as well as by flattening of the convolutions, &c.

The most striking deformity of the brain is anencephaly: the cerebrum is single: it occurs in conjunction with partial or total absence of the face. (Aprosopia.) The brain forms a single sac, but completed by the arachnoid, and filled with liquor. The posterior lobes are so defective, that the cerebellum, quadrigemina, and even the optic thalami, appear wanting, whilst many other parts, the fornix, corpus callosum, small commissures, &c. are also wanting. This anomaly is sometimes thus single in cases of hemicephalus, but sometimes in association with cyclopia. (Ophthalmosmia.) The anomaly, observed in the interior of the brain, which has just been mentioned; it is the absence of the optic thalami and corpora striata of the two

together in the middle: a double or a large commissura mollis is a modification of the same anomaly.

From the opposite condition, deficiency of the commissures, a division of the brain results. The fornix is very rarely wanting, while, on the other hand, deficiency of the soft commissure of the optic thalami is not unfrequent.

The other smaller organs of the brain are rarely misshapen from any fault in their original formation.

§ 3. *Anomalies of Position.*—Disregarding, for the time, the displacements within the skull to which the brain is subjected by various growths, we find the most striking anomaly in respect to the position of the brain to be hernia,—encephalocele,—extrusion through an aperture in the skull.

Congenital hernia of the brain is occasioned by an extreme increase of the organ in bulk. In most cases it is undoubtedly the consequence of hydrocephalus, (hydrencephalocele,) the pressure of which interferes with the development of the bones generally, and, at some particular spot, arrests it altogether. The size and form of the congenital hernia of the brain bears a certain relation to the dimensions of the aperture in the skull, as well as to the quantity of the protruded cerebral mass, and of water accumulated in it: the size of the hernia, however, and the dimensions of the aperture in the skull, are very often proportioned inversely to one another. The hernia is sometimes as large as the head, or larger; more frequently it is below that size. Its form is that of a round tumour, or of an appendage to the skull; and when it is large, and the aperture in the skull small, it appears attached by a neck or pedicle.

The protruded mass of brain is covered externally by the general integuments, which are mostly thin, and without hair; internally, the inner cerebral membranes are in immediate contact with it, while, between the two, the pericranium and dura mater are intimately united with each other. True hernia of the brain must not be confounded with saccular protrusions through the skull, which, though similar, are merely herniæ of the arachnoid: they are sometimes so far combined with hernia of the brain, that, as they increase, a portion of that organ may project within their pedicle.

The protruded portion of brain is sometimes in the same

state of destruction, and consecutive malformation or vitiation of its growth (*Verbildung*), as in the case of *hemicephalus*: the hernia is then combined with *hemicephalus*, the former passing into the latter.

The situation in which hernia occurs is also very various. Most commonly it is at the occiput; and next, though much less frequently, it occurs further upwards in the mesial line, at the anterior fontanelle. More rarely still, it happens in the lateral regions of the skull, and on the forehead: while sometimes, but most unfrequently, the brain protrudes into the nostrils, or sphenoidal sinuses, and forms a tumour at the root of the nose, or in the pharynx.

The skull, in these cases, is altered in size and shape. As more of the brain protrudes, the cranium becomes generally smaller, and its vault flatter; and if, at the same time, the aperture be large, that form of the head predominates which is exhibited in *hemicephalus*. But this rule has its exceptions; for if the *hydrocephalus* be very large, the great quantity of the serum may, in spite of the size of the tumour, not only preserve the skull at its normal dimensions, but even enlarge it beyond them. When the hernia protrudes through the cribriform plate into the nostrils, the vault of the skull sinks, in the form of a saddle.

Hernia of the brain rarely comes on after birth, for it is then only through accidental openings of the skull and *dura mater*, or those made designedly by art, that the brain can protrude. The hernia is effected by the congestion and turgescence of the brain, which are excited by the external injury, by swelling of the brain arising from acute *oedema*, by acute *hydrocephalus*, &c. The protruded portion of brain takes the form of a sausage; it sometimes reaches a considerable size, and measures several inches in length. It is liable to be strangled by the aperture in the skull and *dura mater*, and then frequently becomes congested, and mortifies; and injuries to its free extremity may be followed by inflammation and suppuration.

§ 4. *Deviations in Size*.—Many individuals present peculiarities in respect to the size of their brain; but the organ is subject to other and more essential deviations from its natural bulk. I shall treat first of unnatural excess, and then of unnatural diminution of its volume.

1. *Unnaturally large size of the brain.*—Many morbid conditions augment the volume of the brain, as hyperæmia, hydrocephalus, and œdema, adventitious growths, and hypertrophy, or a combination of any of them with one another. I have here to treat of increase of volume by hypertrophy, which is the most important of these morbid conditions; the others have already been, or will be, mentioned in their place.

Hypertrophy of the brain.—Its general characters are, unnatural size and weight of the organ. It varies in degree; and its importance depends partly upon this variety, but mainly on the condition of the skull. The most serious conditions under which it occurs, are when the hypertrophy is far advanced, and the sutures are closed, as the skull then resists the increase of the volume of the brain.

The best plan will be to begin by depicting such a case.

When the skull-cap is removed, the brain, closely covered by the dura mater, swells up palpably (*turgescit*); on slitting open the dura mater, the swelling is still more distinct, and it costs some trouble to fit the skull-cap on again. All the membranes of the brain are remarkably thin; the dura mater especially is delicate, pale, reddish, and transparent. The inner membranes lie close upon both the dura mater and the surface of the brain. Their lack of the fluid which usually moistens the arachnoid, and occupies the tissue of the pia mater, is quite conspicuous; they are dry, and their vessels are bloodless and flattened.

Before further dissection and comparison the cerebral hemispheres appear large. Their convolutions are compressed and flattened, and the sulci between them are scarcely discernible.

The usual horizontal section through the hemispheres, a little above the level of the corpus callosum, displays a centrum ovale of unusual size.

The ventricles are remarkably small.

When the whole brain is removed from the cranium, the size of the cerebrum again arrests attention, especially when compared with the cerebellum and other parts at the base of the brain, and with the nerves.

It is quite clear throughout the examination that it is the white substance that is increased in volume, the white substance of the cerebral hemispheres. The cineritious matter is

generally of a pale grayish-red colour, the medullary is always dazzling white, and remarkably pale and anæmic; a circumstance both of interest and importance, because it distinguishes the increase in the volume of the brain occasioned by hypertrophy, from that which is produced by congestion.

The consistence of the hypertrophied white substance is quite peculiar; it is elastic, and has the somewhat firm resisting feeling of rising dough.

Having thus sketched the most essential and most striking of the appearances in hypertrophy of the brain, I proceed to detail some results which attend it in advanced degrees of the disease, and at particular periods of life.

a. When the hypertrophy is very far advanced, and the sutures are closed, the pressure sets up some absorption at the inner table of the skull, and it becomes rough: the absorption may even go so far as to make the wall of the cranium distinctly thinner than natural. Inferiorly, the cerebellum and the structures at the base of the brain are flattened and spread out, evidently by pressure from above. The absorption of the inner table generally begins and goes farthest at the vault of the skull, though it appears, indeed, to be most advanced at the base, as the bone, which was there originally thin, is in some parts perforated with holes, produced by the absorption; the orbital and cribriform plates, and the roof of the sphenoidal sinuses, are thus perforated.

β. Enlargement of the skull, as a consequence of hypertrophy, takes place only in the child; but it occurs, whether the bones be held together by interstitial membranes still, or by sutures. The enlargement of the skull, and the hypertrophy of the brain, vary together. In its general form, the skull resembles the hydrocephalic skull.

γ. In some rare cases, among children in whom the disease has rapidly advanced to a considerable extent, the sutures of the skull become loose and separate, especially at the upper part of the head, and the sutural cartilages become suffused, and are of a reddish colour.

Hypertrophy of the brain is sometimes congenital, and is often combined with hydrocephalus; it more usually comes during extra-uterine life, but is almost exclusively confined to the period of childhood. It is occasionally met with about

the time of puberty, and sometimes even in manhood; but at the latter period it is extremely rare.

Congenital hypertrophy is accompanied by very various degrees of arrested development of the vault of the skull, and sometimes, indeed, that part is entirely wanting (acrania), it is attended, also, by general dwarfish growth, and by various faults in the development of the brain, as well as of other organs. When it comes on in childhood and at puberty, it is combined with general enlargement of the lymphatic glands, and but partial obliteration (involution) of the thymus gland: in childhood it is also combined with rickets and a feeble muscular development. And it supervenes upon hydrocephalus, both the congenital and the acquired.

Hypertrophy of the brain usually destroys life with symptoms of pressure on the organ; especially when that condition exists on which I have laid so much stress, viz., closure of the skull. Its course is generally chronic, but not unfrequently it is somewhat acute: the cause of the acute symptoms is found in the fact, that the process, having for some time progressively increased in intensity, at last occasions a rapid and tumultuous addition to the bulk of the brain; but the acuteness is only apparent, for the disease passes unobserved through its first stages, and at length gives rise to severe and rapidly-accumulating symptoms, when it has gone on to a considerable extent.

Children will tolerate this disease, even though it advance to a considerable degree; and after having occasioned a corresponding enlargement of the skull, it may continue throughout life unaltered. This, no doubt, is the explanation of those cases of unusually heavy brain and large sized skull, which are occasionally met with in adults: they are cases in which the size and hydrocephalic form of the skull have given rise to the idea that a foregone hydrocephalus has been cured by hypertrophy of the brain. (Comp. 359.)

Hypertrophy is usually a primary and idiopathic disease; frequently, however, it is secondary, and occasioned by some other disease, more especially by morbid growths; and of these tubercle and cancer are its most frequent cause. Its existence, as a secondary disease, has been hitherto almost unnoticed. But the increase in the volume of the brain, in these cases, is so clearly stamped with all the characters of hypertrophy which I have delineated above, and the frequently inconsiderable bulk of the

morbid growth so entirely precludes our accounting for these characters by any compression it could exercise, that there can be no doubt such a form of hypertrophy does occur. The brain is subject to a swelling, which, no doubt, belongs to this class, in consequence of the pressure exerted on the medulla oblongata when the first two cervical vertebræ are carious and dislocated. This form of increase of volume must, of course, be accurately distinguished from the swelling produced by congestion and œdema.

Lastly, the hypertrophy which has been the subject of the foregoing remarks, is a disease affecting the cerebrum, and especially its white substance. It is rather a frequent disease; not so, however, with hypertrophy of smaller portions of the brain.

Although the latter be an extremely rare occurrence, there can be no question that smaller portions of the brain really are separately hypertrophied. Many of the observations brought forward as instances of this occurrence, are undoubtedly erroneous; adventitious formations infiltrated through the cerebral tissue, may have occasioned at once the enlargement and the error. There are, however, some instances which may be relied on, in which the optic thalamus and the pons were hypertrophied; and I have myself met with a most remarkable case of hypertrophy of the medulla oblongata.

With regard to the question, to be decided by theory and microscopic examination, as to the nature of the added material upon which the increase of volume depends, I have formed the following opinion from repeated investigations:

- (1.) The disease is genuine hypertrophy.
- (2.) It consists as such, not in an increase in the number of nerve-tubes in the brain from new ones being formed, nor in an increase in the dimensions of those which already exist, either as thickening of their sheaths or as augmentation of their contents, by either of which the nerve-tubes would become more bulky;—but,
- (3.) It is an excessive accumulation of the intervening and connecting nucleated substance.

The immediate cause of hypertrophy of the brain may certainly be congestion; but this is by no means sufficient to explain its occurrence. Regarding it from a higher point

of view, I am led rather to believe that the hypertrophy of the brain, and the diseases combined with it, especially the excessive development of the lymphatic system, constitute one disease which is based upon some peculiar state of constitution and mode of growth prevailing chiefly in childhood; a belief which is entertained by others also, especially by Münchmeyer.

2. *Unnaturally small size of the brain.*—Such a condition of the brain may, in the first place, be a consequence of some fault in its original development. The whole brain is then small, but the cerebrum is evidently the most diminished, and its convolutions may not be discernible (microcephalus,—congenital idiocy). Or it is some smaller portion, one of the pairs of cerebral organs, for instance, the development of which, in mass and volume, has been arrested: the anterior or posterior lobes of the cerebrum, on one side or both, the whole cerebellum, or one of its hemispheres, &c. may be thus diminutive.

But far more frequently, the small size of the brain is acquired at a different period of life. It consists then of an arrest of the development of the brain in bulk, in consequence either of premature closure of the sutures of the skull, or of the pressure of the fluid in meningeal hydrocephalus, or of various similar local impediments from without, or else of others, such as dropsy of the ventricles, which operate from within. Sometimes it consists of atrophy of a brain already fully developed. I proceed to a special notice of the last.

Atrophy of the brain.—I may remark, in passing, that the same causes which have been mentioned as interfering with the development of the brain, such as chronic hydrocephalus, or local pressure, may occasionally produce atrophy, either of the whole or of part of it, and proceed to the consideration of the more important instances of atrophy, those which are primary and idiopathic, and those which are consecutive and secondary.

Idiopathic primary atrophy is an affection almost peculiar to old age, and is, within certain limits, a natural process of shrinking or decay (involution) of the organ (*Atrophia cerebri senilis*,—*Senium cerebri*). It becomes, however, a pathological condition, even in old age, if it proceed to a very great extent; and still more, if it come on prematurely at an earlier period of life. (*Senium*—*marasmus cerebri præcox*.)

This atrophy is confined to the cerebrum. Cazauvielh asserts that the cerebellum retains the full size in the aged, which it had reached in the younger person, at the completion of growth. In contrast, however, with the local, or partial atrophy,—that of separate parts of the brain,—it may be regarded as a total atrophy, or atrophy of the whole brain.

The cerebrum is diminished in volume and weight. The former is ascertained from the existence of a new space between the surface of the cerebrum and the skull, and from the enlargement of the ventricles. The convolutions are thinner than natural, and the sulci between them broader. The gray substance is of a dirty, or rusty-brown colour, running into yeast yellow. Its consistence may be normal, or distinctly softer than natural. The fibrous substance has lost its pure whiteness, and has a dirty white tinge; it is denser, too, than natural, and is sometimes as tough as leather. This increase of density (sclerosis) is most marked near the ventricles. The ventricles are dilated, their lining membrane is generally palpably thickened, and is frequently covered with a very fine granular, gritty layer, of a crystalline transparency, or an opaque whiteness. (p. 357.)

More advanced degrees of atrophy and concomitant induration present the following appearance: The surface of a section of the hemispheres shrinks and becomes concave; and, here and there, certain portions offer more resistance than others, and wrinkle and lie in folds: sometimes these firmer portions surround the orifices of the vessels divided in the various sections, and the tissue around the end of the vessel shrinks, and encircles it with a little hard puckered projection.

The fibrous arrangement of the pons, crura, and similar white structures, is rendered more distinct than usual by superficial grooves running in the direction of the fibres.

The porous condition of the white structure of the hemispheres, and of the corpora striata, called by Durand-Fardel "*état criblé*," is also very well marked. It is equally the result of the atrophy of the brain, and of the congestion of the cerebral vessels to which the atrophy gives rise; it consists of an enlargement of the canals in which those vessels traverse the brain.

The vacuum within the skull, produced by the shrinking of

the brain, is filled up chiefly by a clear colourless serum, which accumulates in the sac of the arachnoid around the brain, in the tissue of the pia mater, and in the ventricles. For the same reason, the vessels of the pia mater become varicose, the membranes of the brain increase in volume, and bone is even deposited on the inner table of the skull, especially around the anterior cerebral lobes within the frontal bone.

This form of atrophy, as I have already remarked, occurs in old age; but it may also come on prematurely, and be associated, or not, with manifest senility of the entire organism. When thus premature, it sometimes arises spontaneously; but it is more frequently met with as a consequence of mental diseases which are characterised by excitement, and as the physical cause of the imbecility which follows them. It is one of the results of repeated intoxication and attacks of delirium tremens; and it ensues upon repeated attacks of apoplexy, especially peripheral apoplexy, and upon the processes by which they are cured. Inflammation, too, will bring it on, especially that which is peripheral, and its termination in induration, &c.

It is in itself a very important condition, but it becomes still more so from its immediate and further consequences. Those consequences are as follow:

a. Congestion of the brain.—Hyperæmia ex vacuo. These congestions give rise to the transient or protracted attacks, which simulate apoplexy, and are so frequent in old age.

β. Actual apoplexy, hemorrhage, finds one of its chief causes in atrophy of the brain, and the congestion to which atrophy gives rise.

γ. Œdema of the brain is a very common appearance in the atrophied brain of the aged and imbecile (Calmeil); it may be chronic, or, to a certain extent, acute: and it is attended by effusions into the ventricles.

Atrophy, when it involves the whole brain, and has reached a certain degree, terminates fatally, either by paralysing the brain, or through some of the consequences described above.

Partial atrophy is very rarely a primary and idiopathic disease; much more commonly it is secondary; it presents two orders of cases:

(1.) Those of the first order are represented by two pretty frequent examples; on the one hand, by shrinking of the

optic thalamus and corpora quadrigemina, in consequence of blindness; and, on the other hand, by that of various sets of white fibres after attacks of apoplexy and inflammation, especially when these attacks have taken place at the surface of the brain. The atrophy of one or more parts of the brain, therefore, is consecutive, and arises from disease of the central or of the peripheral extremities of the nerves. The diseases of the peripheral nervous system, which produce such a result, are primary and secondary paralyzes, the original physical cause of which, though various, and for the most part unknown, may, in the end be reduced to wasting of the texture of the nerves. The atrophy of the optic thalamus, &c., in consequence of paralysis of the retina, makes it probable, that many of the atrophies of particular parts of the brain are not the cause of peripheral paralysis, but rather the consequence of it; *i. e.*, that the atrophy is propagated from the periphery to the corresponding centre in the brain. The principal diseases of the central extremities of nerves are wasting of the cerebral substance after inflammation and apoplexy, of which I shall have to speak hereafter.

(2.) To the second order of cases belong those losses of substance, those atrophies, which result from inflammation and apoplexy; in which so much of the substance of the brain as was broken down by extravasated blood, or disorganised by inflammatory processes, is altogether removed by absorption, together with the extravasation and the exudation. These are instances of secondary atrophy, occasioned by previous disease of texture. And they are cases, which, especially when the loss of substance is at the periphery of the brain, give rise to the atrophy of different sets of the fibres, as I mentioned among the first order of cases: they may even be so extensive as to occasion wasting of an entire hemisphere, and of the fibres continuous with it in the crus, the pons, the medulla oblongata, and the medulla spinalis.

As these cases of atrophy proceed, they always give rise to well-marked induration (Sclerosis) of the portion of brain which they involve: and that half of the brain in which they occur, and even sometimes the whole brain takes part in the induration too. Atrophy of an entire hemisphere of the cerebrum produced in this manner, is sometimes concentric; sometimes its lateral

ventricle is dilated, and then it is excentric. The former, or the case in which the hemisphere shrinks upon itself, is the more usual of the two. In the latter there is a one-sided dropsy of the ventricles.

When the atrophied portion is seated on the surface of the brain, the vacuum is filled up by thickening of the adjoining part of the membranes, by œdema and bulging of the pia mater, by enlargement of the collateral ventricle, and even by the wall of the skull sinking in. When it is deeply seated, its place is, under certain circumstances, after apoplexy, for instance, occupied by serum; and the cavity thus formed exists for some time, and may even continue permanently.

Cases of partial atrophy sometimes bear a very close resemblance to those in which the brain being originally of small size, or defective in some of its parts, consequently presents an originally unsymmetrical appearance. But the atrophy may be distinguished by the induration which it produces in the part which is diminished in size, as well as by the induration of the cerebral substance around, while the vacuum and the complementary serous effusions distinguish it when the skull is found symmetrical, and the rusty-brown, or yeast-yellow colouring of the brain determine when apoplexy has preceded the atrophy, &c.

§ 5. *Solutions of Continuity.*—Amongst these are classed in the first place, various incised, punctured, and shot wounds, contusions, and lacerations of the brain: the latter are produced partly by the instrument with which the injury is inflicted, and partly by the splinters of bone which are depressed or driven in; and partly they are independent of both these causes, and are the result of the violent concussion which the skull has sustained. They are found most commonly at the seat of the injury, but sometimes at other distant points also, deep in the brain, or as is more frequently the case, just opposite the injured spot; and sometimes they exist at several of these points together. The condition of the brain at these parts, varies according to the amount of the injury: either there is no perceptible solution of continuity, but the brain is more or less suffused, that is, sprinkled with red dots and streaks of extravasated blood, (capillary apoplexy,) and uniformly tinged also of a deep red

colour with blood; or it is distinctly ruptured, and the intervals are filled with extravasated blood; at other times, the cerebral substance is bruised to a uniform pulp, and of a paler or a darker red colour, according to the quantity of blood extravasated into it.

Moreover in sanguineous apoplexy, the brain undergoes spontaneously a laceration, a breaking down, a concussion, exactly similar to that produced by mechanical injury. In the higher degrees of dropsy of the ventricles, as I have already mentioned, the septum may be perforated, the soft commissure torn, &c.; and in some rare cases (see p. 363) the cerebral substance around the ventricles bursts, and the serum escapes.

Incised and punctured wounds, when slight and clean, sometimes heal by adhesion; and the slighter cases of contusion are repaired in the same manner as hemorrhage in the brain; but more extensive injuries give rise to greater degrees of inflammation, to suppuration, and yellow softening, and sooner or later destroy life. Wounds from which loss of substance ensues, heal by granulation, which fills up the cavity, and adheres to the cicatrix that supplies the place of the cerebral membranes and bone. And in this case, the space within the skull is also partly filled up by an enlargement of the ventricle of the same side, proportioned to the quantity of substance lost, and to the difficulty of replacing it with granulation and cicatrix. Sometimes the granulation is exuberant, and grows up to, and beyond the opening in the skull, presenting a condition long known to surgeons by the names of *fungus cerebri*, and *hernia cerebri*.

There is one case which calls for especial remark in this place, namely that of concussion, without any perceptible lesion of the continuity of the brain. It results from a fall from a height, and is usually combined with extensive shattering of the skull. It is rapidly fatal; and after death the brain is frequently, though not always, found manifestly collapsed and bloodless. But it may also be produced by force applied to a circumscribed portion of the skull. A solution of continuity, often inconsiderable, then ensues in the skull, a small extravasation occurs over or under the dura mater, and subsequently inflammation, necrosis of the bone, and inflammation and suppuration of the dura mater take place at the injured spot. These are not unfrequently preliminaries of a diffused inflammation of the pia mater (*meningitis*); though sometimes the *meningitis* comes on with-

out such antecedent. But the gravest of all are those rarer cases in which, not only without any of these occurrences in the neighbourhood of the brain, or perceptible lesion of its continuity, but even, without the slightest subsequent alteration of its structure that can be detected, an affection of the brain supervenes, either immediately upon the injury or some time after, and proves fatal. In some cases of this kind, which are well known to distinguished surgeons, as well as in others in which the violence inflicted was attended with palpable structural disease of the brain, I have observed not only a remarkable emaciation of the whole body, but more especially a very rapid disappearance of the mass of the blood (anæmia), which was the more conspicuous from the previously full habit of the patient.

§ 6. *Diseases of Texture.*

1. *Hyperæmia, — Anæmia.*—Congestion of the brain is a very common appearance; and it is generally associated with a corresponding degree of congestion of the pia mater.

Its anatomical characters are—first, injection of the cerebral vessels, and the appearance of an unusual number of bloody points on the cut surface of the brain. The gray substance, when but slightly congested, exhibits some shades of red, and in young persons, and especially in the child, it presents distinctly a bright-red colour. In intense congestions, the fibrous substance loses its clear whiteness, and, in children particularly, acquires a grayish-red, and in some very rare cases a red hue. The brain is swollen; but its increase in size is distinguished from that enlargement which occurs in hypertrophy of the brain (p. 373), by the turgid condition which has evidently given rise to it. Bouillaud has called attention also to a firmer consistence of the brain, as occurring in congestion; it is, however, by no means a constant, and still less an essential appearance.

Hyperæmia of the brain takes place in the course, or follows as a consequence, of very various acute and chronic diseases. It is sometimes active, sometimes passive; and it may be mechanical. Occasionally it arises from none of these causes, but comes on independently; and then it may be transitory or persistent, or may recur and become habitual. Congestions of the last kind occur especially in childhood and at the period of puberty. Hyperæmia is an important condition when it is

produced and kept up by structural disease, as may readily be observed in all new formations in the brain and cavity of the cranium, and especially in highly vascular turgid structures, like cancer of the brain. Those congestions, also, which result from the existence of a vacuum in cases of atrophy of the brain, and which were referred to at page 379, are of considerable importance.

Among the consequences of hyperæmia, slight and repeated congestions may be mentioned as leading, especially in childhood, to hypertrophy of the brain. Another frequent and a fatal consequence of it is œdema of the brain, which may be acute or chronic, according to circumstances, and attended with an effusion of serum into the ventricles. Moreover, there is no question that hyperæmia proves fatal in cases known as vascular apoplexy. Such a result is met with in the course of many acute diseases, which give rise to local congestions. Diseases of the brain itself, especially hypertrophy, and different new formations within the cranium, the pressure of which displaces the organ, often produce sudden death by the congestion to which they give rise; and, lastly, diseases of the lungs, the heart, and the great vessels, which obstruct the circulation, and especially those which prevent the free current of venous blood towards the heart, are frequently terminated by mechanical congestions.

It is a question of much importance, whether the frequent cases of sudden and unexpected death in previously healthy persons, in which the only or the principal post-mortem appearance is a certain amount of congestion, are produced by this congestion, and are to be considered as cases of palsy of the brain from hyperæmia, whether in fact such congestions are sufficient to cause death or not.

a. In answer to this question, I may remark, that, in a certain number of the cases referred to, this congestion is the only morbid appearance in the body, and has reached a degree which, in the present state of our knowledge, justifies the conclusion that the brain has been paralysed by it. But the number of such cases is comparatively very trifling.

b. In a considerable number of cases, again, moderate congestion of the brain is found associated with hyperæmia of the lungs. It is scarcely possible to say which of these conditions was the primary, and which the secondary, whether the

not spring both together from the same source, and which of them actually produced death. But as it is quite common for congestion of the lungs to be the only morbid appearance in cases of sudden death, and as it is decidedly the more marked appearance when cerebral hyperæmia is present also ; we may, in determining the mode in which death has taken place in these cases, conclude that the congestion of the brain is usually of secondary importance.

c. Besides cases of these two kinds, there is still a number of others in which all that is discovered upon examining the body is so slight a congestion of the brain, that it would not be thought of, if any other morbid appearance presented itself. The mode of death in most cases, and especially of sudden death, is still too little understood to allow us to say positively whether these congestions are the efficient cause of it, or are merely accidental phenomena, and dependent on the agony ; but perhaps we may say that there is an individual tendency of the brain to palsy (*Lähmungsfähigkeit*), just as there is an individual liability to death (*Sterbensfähigkeit*), and so incline rather to the former opinion, that in certain persons such congestions may prove fatal.

Persons of what is called an apoplectic habit, are far less subject to congestions of the brain, and particularly to vascular apoplexy, than those of an opposite conformation, and than children.

Anæmia of the brain is a highly important condition, and one very dangerous to life. It is usually a local part of the general bloodlessness produced by hemorrhage, or by the consumption of the blood which takes place in the course of acute and chronic diseases. A very remarkable instance of anæmia is that which arises from the contraction or obliteration of the vessels, which convey blood to the brain : it is effected by deposition on their inner walls, and may occur at any part of their trunks, or at their orifices in the arch of the aorta. (See *Anomalies in the Calibre of Arteries*, vol. iv.) It is a very important condition also when it results from hypertrophy, swelling, compression, or displacement of the brain in cases of sanguineous apoplexy, inflammation, yellow softening, or new formations.

2. *Cerebral hemorrhage*.—Hemorrhage (*Apoplexia sanguinea* ; *Apoplexia gravis*) is a very common disease in the brain,

and is often suddenly fatal. I class it with hyperæmia, although it is not necessarily accompanied or caused by striking congestion.

Cerebral hemorrhage consists in an extravasation of blood into the substance of the brain, and a solution of its continuity corresponding in extent to the amount of the bleeding; the latter injury consists generally of breaking-down, laceration, or contusion of the cerebral substance.

The intensity of the hemorrhage, the number of the bleeding vessels, and the nature and extent of the disorganisation of cerebral substance occasioned by the extravasation, produce many marked varieties in the form of the seat of hemorrhage.

Sometimes a spot of gray or white cerebral substance, varying in extent, is speckled or striped with a small number of dark red dot and streaks of extravasated blood (ecchymosed): the streaks run parallel to the nervous fibre, the intermediate cerebral substance preserves its normal colour and consistence, and, where the fibres of the brain run in one direction, it seems to the naked eye merely drawn asunder, some few only of the elementary parts having suffered an actual solution of continuity.

At other times the number of these extravasations is more considerable: they lie closer together, and some of them having coalesced, are thereby increased in size. The cerebral substance appears to be uniformly suffused, and coloured with various shades of red: it is of a soft pulpy consistence; and, apparently, in consequence of the number of original small extravasations, and still more by the confluence of larger ones, it is broken into numerous shreds, and softened to a red pap.

When this is the case, the small extravasations become more numerous, and, still coalescing, produce more and more extensive destruction of the intermediate cerebral substance; and thus, as the other extreme, we find all the primary small extravasations united in a single great one, which includes the broken-down interstitial substance of the brain, and is itself contained in a cavity of lacerated, and bruised cerebral tissue.

This, therefore—the apoplectic cavity (Herd)—proceeds from hemorrhages occurring at several points at once,—from the confluence of many small cavities. The form first described has received the name of Capillary Apoplexy.

An extensive cavity is, however, sometimes formed in another manner, viz. by the independent enlargement of a single small extravasation in consequence of the continuance of the hemorrhage; for there are some single and very small extravasations, of the size of poppy- or millet-seed, which, when the hemorrhage continues or recurs, increase rapidly or by degrees, and tear and separate the surrounding cerebral substance in various directions. Though the tissues composing the walls of such a cavity, may resemble the broken-down structures already described, yet the extravasated blood which it contains is, in its interior strata, at least, free from all admixture of cerebral tissue.

It is not clear whether one form of the hemorrhagic cavity may, from any particular morbid cause, be occasioned by the other; but it appears, nevertheless, as if that described second, were principally dependent on hypertrophy of the left ventricle, and gave rise to the large (*foudroyantes*) cavities which prove suddenly fatal.

The apoplectic cavity, whether produced in one way or the other, presents varieties, when recent, which are important in several respects.

Seat of the hemorrhage.—It happens in the cerebrum far more frequently than in any other portion of the brain. The cerebellum is comparatively very seldom attacked, and the pons yet more rarely. Its occurrence in the corpora quadrigemina, the pons, and the medulla oblongata is quite exceptional, and it almost never happens in the corpus callosum, the fornix, and the hippocampi. There is, however, pretty frequent exception to this rule; for when a large cavity is formed in the cerebrum, one or more small secondary cavities are found also in other parts of the brain, especially in the cerebellum and the pons.

In the cerebrum, the situations in which hemorrhage principally occurs are the optic thalami, and corpora striata; from them the white substance of the hemispheres is invaded: the gray matter of the convolutions also is a common site. The cavity is less frequent in those fibrous parts of the hemispheres which are distant from the seats of gray matter.

From this it is evident that the masses of gray matter, and those portions of the brain which contain considerable quantities of gray matter, are eminently the seat of apoplexy. It is

necessary, after which, these general facts, to permit of a diagnosis.

The situation of apoplexy, also, depends, that of the part of the brain, and that depending on the central parts is not of value, inasmuch as the disease is followed by great changes in the electrical conditions of considerable extent. When apoplexy is almost always accompanied by the rupture of the aneurysm.

Something also is known of the ventricles, and the rupture of the ventricles, which is frequently supposed to originate not in the corpus striatum and optic thalami, but from the lateral ventricles, and the vessels supplying them is an extremely rare occurrence. It must not with it, as the case has been, in a very large suppurated hydrocephalus.

The only rule to be then that of the passage, or rather the fact of the rupture, and even beyond, as that at length it is included in the hemisphere of the ventricles. This part is more the seat of the largest arteries. It not infrequently happens that they burst through the brain, either through its surface, or more commonly inward, into the cavity of a lateral ventricle, as might, indeed, be expected from their being more usually situated in the optic thalami and corpus striatum. The consequence in the former case is extravasation, first, into the tissue of the pia mater, and then between it and the outer layer of the arachnoid, to a greater or less extent. Not infrequently the whole of the pia mater surrounding the lateral hemisphere is suffused, and free extravasation is poured out even into the ventricles. In the latter case, the first and immediate result is the effusion of a large quantity of blood into the collateral ventricle; it passes into, and fills, the opposite ventricle, producing, at the same time, much laceration of the septum and fornix. The effusion proceeds into the third, and thence into the fourth ventricles, and from the ventricles into the pia mater all round the brain, but especially at the base. The size of the rent varies; it may be an inconsiderable fissure, or a large cleft, gaping into the ventricle; the latter is especially the case in the corpora striata and optic thalami.

In peripheral apoplexy, or apoplexy of the superficial part of the brain, the cavity is covered in, and closed by the pia mater, and the tissue of that membrane is suffused. In superficial

extent, peripheral apoplexy usually includes the space of about a square inch.

The smallest cavities occur in those parts of the brain, in which apoplexy is, in general, less frequent, although some cavities, of the size of walnuts, are not very rare in the pons, and even larger still in the cerebellum.

The *number* of recent cavities is also various. Usually but one is found, though to this there are frequent exceptions. With very large and suddenly-fatal cavities in the cerebrum, one or several others, in different parts of the brain, are very commonly associated, which are secondary to the former in point of size. It is also interesting to observe, sometimes, in the very atrophied brain of old persons the simultaneous, or nearly simultaneous, occurrence of very numerous small cavities: they equal millet-seed, hemp-seed, and even beans in size, and occur in different parts of the brain.

It is also remarkable that two symmetrical cavities are sometimes found in corresponding organs of the brain, for instance in the corpora striata.

The *form* of the cavity, when small, is generally round or elliptical; in fibrous parts, like the pons, it is very often a slit parallel to the fibres: larger cavities are more irregular, and are dilated into pouches in various directions.

The parts around, constituting the *walls* of the cavity, consist of cerebral substance more or less extensively suffused, red, and broken down into a soft and very moist pulp: in large cavities, ragged shreds of it hang into the cavity.

The *contents* of the cavity, too, the extravasated blood, present numerous varieties. In the first place, as has been already explained, it may, or may not, enclose shreds of the destroyed cerebral tissue. Its quantity corresponds with the size of the cavity, and may amount to six, eight, or even ten ounces.

There are many diversities both in the *degree and the manner of its coagulation*. Sometimes the whole extravasation becomes one uniform thick, blackish-red mass; at other times it is partly fluid, and partly in clots of various consistence: occasionally there is a more marked separation into a fluid portion and one coherent cake; or the entire mass has congealed into a sort of placenta that fills out the cavity and assumes its

form. Here and there, moreover, the fibrin may be separated in the form of clots, or cords, or membranes, which pervade the blackish-red cake. It is of much importance to remark those forms of coagulation, not hitherto observed, in which the fibrin, when in considerable quantity, is deposited around, and encloses the clot and serous portion—the *peripheral* form,—or is lodged as a *central* clot, in the interior of the coagulated mass. Each form opposes permanent obstacles to the healing, that is, the contraction and closure, of the apoplectic cavity.

Lastly, a brain, which is the seat of apoplexy, suffers not only a solution of continuity at the part itself, but also some displacement corresponding to the size of the cavity. The cerebral substance surrounding the cavity is stretched and torn, the segment of the brain containing it is enlarged, swollen, and more or less altered in form, and a portion of brain swollen by a large cell is found to fluctuate, when much of the effused blood has not coagulated. The pons is thus enlarged around a cell in its centre, especially in breadth; but the changes are most striking when one of the cerebral hemispheres is occupied by a large apoplectic cell. It is forced against the dura mater and cranium, and inwards against the opposite hemisphere; it becomes prominent and convex towards the falx cerebri; it feels quaggy (*schwappend*,—wabbling); and if it enclose a very large cavity, it ruptures on the removal of the dura mater. The inner membranes are thin; the serum, which had been previously infiltrated through them, is removed; their vessels are compressed; the convolutions are driven close together, flattened, and diminished in size; the structures at the base of the brain are flattened, the opposite ventricle is narrowed, and its contents are displaced. When a cavity of this kind opens into the ventricle, the opposite hemisphere also shares in the enlargement, &c., as much as is possible.

Recent apoplexy is followed by numerous changes in the cavity itself, in the cerebral substance around it, and even in the whole brain; and the description of the recent cell may now be followed by some account of them. They include, in a word, the terminations and consequences of apoplexy, provided a fatal result has not ensued suddenly, or after some short period, such as a few days. I will speak first of the changes which attend a favorable result, and constitute the reparative

process in apoplexy. A representation of this process can be obtained only by numerous observations on persons who have died at various periods after an attack of apoplexy. The parts in which these changes occur, are *the extravasated blood*, and *the surrounding cerebral substance*, or wall of the cell.

Numerous changes of colour gradually take place in the extravasation; it becomes blackish-red, then brown, of the colour of plum-sauce, rusty brown, and yellow, like yeast: at last this colour also fades completely, or nearly so; and there remains only a clear and colourless, or a turbid white fluid. Corresponding alterations take place also in the consistence of the extravasation, and in its general composition. They are manifested on the whole in the extravasation becoming fluid, the fibrin and blood discs being absorbed, and in the progressive changes in the pigment which have been mentioned.

The shreds of cerebral substance contained in the extravasation are also absorbed, and disappear entirely.

Whilst these changes are going on in the contents of the cell, we observe others also in its *walls*.

In the first place that portion of the wall of cerebral tissue which is suffused, torn, and disorganised, and which hangs into the cavity in the form of pulpy shreds, becomes partly absorbed, and partly fluid, so that the inner surface of the wall acquires a polished appearance, and the cavity itself a more regular rounded form. A reactionary inflammatory process then commences in the neighbouring uninjured cerebral substance: it is moderate in degree, and its products partly undergo a change of structure, and partly both they, and the cerebral tissue, which is the seat of the process, become reduced to a fine molecular mass, and are gradually absorbed. In its general appearance, therefore, this layer seems to consist of fibrils like cellular tissue, of numerous nucleated structures, some rounded and others elongated into fibrils, of delicate nucleated fibres, of elementary nucleoli, partly separate, and partly conglomerate, and forming the so-called exudation-corpuscles, and of a certain quantity of yellow, or yellowish-red, amorphous pigment. And, according to the amount of one, or the other, the density of the layer varies: if the formation of new tissue predominate, its density is considerable, while in many cases we find it to be made up of honey-combed com-

partments, the partition-walls consisting of these fibrillated structures, and the intervals being filled up by a thick, white fluid, like lime-water, which is composed of the molecular matter already spoken of. After the absorption of the latter, the layer always increases in density, and appears like a cicatrix surrounding the apoplectic cavity.

Meanwhile the extravasation within the cavity has undergone the changes, already generally described. The fluid contains a quantity, varying according to circumstances, of separate or confluent elementary corpuscles, and is dotted with more or less, brown, yellowish-red, or yellow pigment, which may be either amorphous, or in the form of very small prismatic crystals. Moreover the cell is either traversed by a delicate network of varying firmness, which contains this fluid in its intervening spaces, or it forms a simple cavity with its walls lined by a similar network. Minute examination proves this to be a gelatinous blastema, which is gradually resolved into exceedingly fine fibrils, and contains many of the elementary granules, separate or conglomerate, and a greater or less quantity of pigment. It constitutes what is looked upon as the characteristic lining of the cavity when changed to the so-called *Apoplectic cyst*.

In this lining membrane and the equivalent network, just as in the fluid that fills its cells, the pigment sometimes gradually disappears, at least from the naked eye; an exceedingly small quantity remaining perceptible with the aid of the microscope. Indeed, the presence of pigment has less weight in the diagnosis than is ascribed to it, as similar pigments remain after many other processes, which are attended with extravasation, though it be only in the form of the smallest ecchymoses. I may instance, especially, inflammation.

This lining membrane is found at later periods gradually to change into a finely fibrillated cellular tissue: it becomes more compact and smooth on its inner surface, the lining of the apoplectic cyst looking, in fact, like a serous membrane. Sometimes new vessels are formed in it.

The apoplectic cavity is, in general, capable of a still further reparative change, or decay (involution): viz., *gradual contraction and finally closure—wasting of the apoplectic cyst*.

This result ensues when the lining of the cyst is sufficiently penetrable to admit of the absorption of its fluid contents.

The cyst becomes gradually smaller, especially in the diameter corresponding to the course of the fibres in its neighbourhood: and its walls approach one another, and finally unite. The spot where the cyst has existed, is then generally marked by an elongated callus (apoplectic cicatrix), containing frequently, though, as I have already said, not constantly, a streak of pigment in its centre.

The period occupied by these different changes, up to the complete healing of the apoplectic cell, cannot be accurately determined. In general, it may perhaps be said, that the apoplectic cyst is formed within two or three months, but nothing is certain with reference to its subsequent changes and closure. These depend mostly on the size of the cyst.

I proceed to mention the most important of the conditions under which the shrinking and closure of the apoplectic cyst are impeded and entirely prevented.

a. Large cysts generally do not cicatrize; their size certainly diminishes more or less; but after this they generally remain permanently: there is, however, an occasional exception in the case of considerable contraction, and almost, and even quite, complete closure of very large cells.

b. Vascularity of the lining membrane of the apoplectic cyst appears to present an obstacle to this result, as it is not unlikely that a secretion of serous fluid may coexist with absorption.

It is, indeed, not improbable, that under such a condition the cyst may even become enlarged, as a consequence of the atrophy of the brain which follows an attack of apoplexy, and the congestion and increased secretion of the vascular lining resulting from the atrophy.

c. An especial and a permanent obstacle to the contraction and closure of the apoplectic cyst, is found in the fibrin being separated, while the extravasation is recent, in the form of a peripheral, or of a central, clot. In the former case, the extravasation lies enclosed in a capsule of coagulated fibrin, coloured red from admixture with the colouring matter of the blood, just as in the extravasations into the sac of the arachnoid. The changes already described go on in its interior; while externally, in the contiguous cerebral substance, the reactionary process advances to the formation of a callous wall. But the compactness of this capsule of fibrin renders absorp-

ones, as has been already remarked, not only continue for a long time, or permanently, in the condition of the apoplectic cyst, but they become manifestly larger, and give rise at the same time to considerable atrophy of the brain. The cause of this unquestionably is, that the vascular structure composing the outer wall of the cavity, viz., the pia mater, becomes congested in consequence of the vacuum existing within the cranium, and serum exudes from its vessels into the cavity. In the situation of such cavities the membranous wall is seen projecting, in the form of pendent, fluctuating bags.

The cerebrum affords the best opportunity for observing the healing process just described. Very large cavities close in this part, and even in the cerebellum also, at least so far as to leave merely a small cavity, or cyst, which in itself is not injurious. In many portions of the organ, especially in the pons, where, on the whole, apoplexy is not very rarely observed, only very small cavities heal completely. It is generally believed that cavities, the greater diameter of which is parallel to the course of the fibres of the brain, and in which, therefore, the mass of cerebral matter is more thrust asunder than really destroyed, heal, that is, close, more readily than those which are oppositely situated. The observation made above (p. 392) may be connected with this, that the contraction of the apoplectic cyst takes place especially in the diameter which is parallel to the direction of the contiguous fibres.

Although the process of healing may be going on, and a cavity be in a favorable state, it may yet prove fatal secondarily at any period. The further terminations and consequences of apoplexy may, therefore, be introduced here.

a. Apoplexy may be fatal at once, primarily, and suddenly, (apoplexie foudroyante) or after a short time, some hours, or a few days: and death, in such cases, results from the extensive destruction of the brain, and from pressure. Of this kind are large central cavities, those of the size of a hen's egg, and even smaller. Still more certainly fatal are larger ones, which burst into the meshes of the pia mater without, or the cavity of the ventricles within. In certain parts of the brain, again, as the pons, medulla oblongata, corpora quadrigemina, a cavity which is not absolutely of inordinate size, may prove fatal by its suddenly withdrawing the influence of the brain from vital functions.

brain, and, thereby, repetitions of the apoplectic attack; as well as chronic, and even acute, œdema, if it should be occasionally increased.

ζ. A varicose state of the cerebral vessels sometimes comes on in the neighbourhood of the apoplectic cyst and cicatrix.

All these appearances, either singly or together, are more developed in proportion to the size of the apoplectic cavity, and still more in proportion to the number of attacks. But extensive, and frequently repeated, peripheral apoplexies are, as has been already noticed, most remarkable in this respect; and it is in these that the most marked examples of imbecility and weakness of intellect occur.

In the few cases I have observed of primary hemorrhage into the lateral ventricle, the extravasation had always coagulated into a rounded cake, and was either loose or lightly adherent to the wall of the ventricle.

In conclusion, I turn to the pathogeny of hemorrhage in the brain. It is, in my opinion, entirely within the scope of anatomical inquiry.

The source of the hemorrhage is the finer vessels and the capillaries of the brain, one or several of which are ruptured. The rupture, however, of so large a number of vessels as we observe even in a cavity of only moderate size, is far from being entirely primary; by far the greater number are torn secondarily in the common destruction of cerebral tissue, by the increasing effusion.

The first that meets us in the search for the causes of apoplexy is—

1. Manifest external violence, producing traumatic apoplexy; it may act either directly upon the skull, or indirectly through the trunk, and produce concussion of the brain: in the former case, wounds of the soft parts of the head, and injuries of the skull itself, are usually associated with it. Most frequently these forms of apoplexy are rapidly fatal, by the general paralyzing effect of the concussion upon the whole brain. The mode of their origin is evident.

2. A second class of apoplexies are those which result from different pre-existing anomalies, the mode of action of which may be more or less clear: they are named *spontaneous apoplexies*.

The mode in which these spontaneous apoplexies arise remains now to be examined ; and, in order to omit none of their causes, all the circumstances under which they occur, may, I think, be so arranged as to afford a useful survey of the most important facts.

Cerebral hemorrhage is not unfrequently observed in the course of convulsions, especially puerperal convulsions and epilepsy. It is generally very extensive and rapidly fatal.

It occurs also sometimes in the neighbourhood of tumours, tubercle, and cancer of the brain.

Occasionally, inflammation and obstruction of the venous trunks of the pia mater, or of the longitudinal sinus, are attended with hemorrhage in the contiguous substance of the brain ; it occurs also in the neighbourhood of inflammation (red softening), as well as in the inflamed spots themselves.

Sometimes it takes place in pregnant females, and persons with distorted spine, when the lungs are morbidly dense.

In some very rare cases in which congenital hydrocephalus is increasing rapidly after birth, blood escapes either into the cerebral substance or into the cavity of the ventricles from the vessels ramifying on their dilated walls.

Sometimes it occurs in the course, or as the consequence of fevers, particularly the typhus and typhoid,

And occasionally during the progress of Bright's disease of the kidneys (albuminuria).

Apoplexy appears in the body under all these circumstances, both in the form of the cavity, and, not unfrequently, in the capillary form.

Hemorrhage very commonly occurs in the brain in persons labouring under simple hypertrophy, or hypertrophy with moderate dilatation of the left ventricle of the heart. The coincidence of apoplexy with this disease of the heart is so constant as to afford ground for stating it as a rule (*constitutio apoplectica cordis*).

The arteries are very often found diseased in cases of apoplexy, in the form of bony or atheromatous concretions, and of fatty degeneration and brittleness of their middle coat. The arterial trunks, especially within the cranium, are then also thickened, rigid, ossified, and brittle, as well as enlarged (especially in the form of *aneurisma cyrsoideum*). Hence it

may be inferred, that the more minute arteries, and even the capillaries within the brain, are in a similar condition: especially as the former are, in fact, sometimes found ossified, and the brain appears as if filled with stiff wires. This, of course, very often coexists with hypertrophy of the heart.

The brain is very liable to hemorrhage, if it be the seat of atrophy, whether spontaneous or however produced; but especially of that atrophy which is the result of previous apoplexy.

Finally, it is very common in advanced life, when the two last-mentioned causes are so often present together. All these forms of apoplexy appear in the body as more or less extensive cavities, and they are very often rapidly fatal.

Reflecting on these circumstances under which hemorrhage occurs in the brain, we discover the proximate causes to be, in general, *congestions, excessive action of the heart, and disease of the blood-vessels*. All, when they have attained a certain degree, lead to rupture of the vessels.

The *congestions* are of various kinds: convulsions produce congestion, which may be active or passive, according to circumstances, and rupture the vessels by the violence of the heart's action.

Apoplexy in the vicinity of tumours, or of inflamed and obstructed veins of the pia mater, or sinuses of the dura mater, or when occurring in connection with morbid density of the lungs, and consequent dilatation of the right ventricle of the heart, is the result of mechanical hyperæmia, whether the cause of the hyperæmia be near the apoplectic spot or remote from it.

Apoplexies which occur during, or subsequent to, typhus and typhoid fevers, arise from the congestions (active and passive) which are notoriously so frequent in the brain, as well as in other organs, in the course of those diseases.

A similar remark applies to the apoplexy met with in the course of Bright's disease of the kidney; in the production of which, however, mechanical influences must also be taken into account, especially the defects which are so frequent in the valvular apparatus of the endocardium.

In the apoplexy of congenital hydrocephalus, the congestions which give rise to the rapid increase of the original affection, and the stretching of the cerebral vessels which results from

this increase, both predispose, the latter mechanically, to rupture the vessels.

But the hitherto unnoticed congestions, arising from vacuum in atrophy of the brain, are of by far the most importance. These, when alone, and more especially when combined with brittleness of the vessels, are, without doubt, the cause of the frequency of apoplexy in advanced life, and particularly of its recurrence in some cases.

The hypertrophies of the left ventricle of the heart, mentioned above, occasion rupture of the cerebral vessels, by the violent impulse which they give to the blood.

The disease of the vessels alluded to, involves, as is well known, brittleness, and a tendency to easy rupture, of their coats. Such a state of the coats of the vessels appears to some extent necessary as a cause of apoplexy, for it is often observed that the deepest congestions, whatever their nature, but especially those intense mechanical ones which give rise to cyanosis, do not produce apoplexy.

And, further, the last two causes, viz., increased impulse of the left ventricle, and disease of the vessels, have such a reciprocal supplementary influence, that the more developed one is, the less amount of the other seems necessary to occasion apoplexy. Thus, so soon as the disease of the vessels has reached a certain extent, hemorrhages very commonly occur in the brain, without increase of the action of the heart, and during a state of quietude both of body and mind. A similar occurrence has been already referred to, in the instance of spontaneous rupture of large arteries. (See *Dissecting Aneurism*, vol. iv.)

There is no single cause that will account for the frequent repetition of attacks of apoplexy in many individuals, and its simultaneous appearance at several different spots in the brain, but the presence of disease of the vessels. This also partially explains its happening symmetrically in corresponding portions of the brain at the same, or nearly the same, period. (See the remarks on the symmetrical occurrence of *Disease of the Arteries*, vol. iv.)

The liability to cerebral hemorrhage is of course greater, in proportion to the number of the adduced causes that are present. The congestion arising after atrophy of the brain from vacuum within the cranium, hypertrophy of the heart, and dis-

case of the vessels, very frequently exist together in advanced life.

Among the predisposing causes, all mention of the so-called *habitus apoplecticus* might be omitted. And the omission would be justified by the facts; for the notorious "Constitutio Apoplectica" is a mere hypothesis, which is refuted on every occasion. The apoplectic habit predisposes much more to congestion and vascular apoplexy of the lungs, which, indeed, as it induces acute œdema of those organs, is very commonly fatal, and is, unquestionably, the most frequent of all the modes of sudden death.

I have also made no allusion to *yellow softening of the brain*, as a predisposing cause of apoplexy. But, without entering into any further observations, I may remark that, though it not unfrequently follows, I do not recollect any case in which yellow softening of the brain, as a primary disease, had given rise to hemorrhage.

It appears from what has been said, that as the occurrence of hemorrhage in the brain is entirely mechanical, all the predisposing causes are mechanical also.

Though quite convinced that this is the fact, I can scarcely avoid entering upon the question as to the existence of some morbid state of constitution, or dyscrasia, as a cause of apoplexy; especially as analyses of the blood of apoplectic persons have recently been published, the results of which seem to point to the blood as the cardinal predisposing cause of apoplexy.

It may be reasonably doubted whether any morbid state of the blood could have the effect of rupturing vessels without some previous alteration in the structure of their coats: such a result could ensue only from a state of morbid expansion of the blood; such, for instance, as occurs in typhus and typhoid fevers, in combination with congestion. I certainly, however, agree so far, that a certain anomalous condition of the blood does coexist with those circumstances under which apoplexy is most frequently observed; only, as we shall see, it never is an essential predisposing cause, but is itself conditional upon, and subordinate to the mechanical relations. Such are:

1. The abnormal state of the blood, which is developed in the course, or as the consequence, of hypertrophies of the heart—a venous crasis—cyanosis.

2. That morbid condition of the blood, which gives rise to the accumulation of an inner membrane upon the vessel by deposition from the arterial blood, and thereby to the so-called ossification of the arteries: and also that morbid condition which, after deposition has taken place within the arteries, may be occasioned by the absorption of the elements constituting the atheroma of the artery, especially the fat. No accurate information has hitherto been obtained as to the characters of these morbid states of the blood.

3. A change in the condition of the blood, which occurs in advanced life, and is brought on by atrophy of the brain, but which loses its importance in the presence of the coincident mechanical causes.

The results of the analyses instituted by Andral and Gavarret, on the blood taken from persons suffering from the preliminary symptoms of apoplexy, as well as after the attack, prove clearly the existence of a morbid condition of the blood, but I maintain that they lead to no further result than that the blood of the persons spoken of, is thus composed. So long as more numerous and more widely extended analyses are wanting, it may be asked, without reference to the denial that this state of the blood gives a predisposition to hemorrhage in the brain.

1. Is not this just the condition of the blood which is found in individuals with hypertrophy of the heart, or in those who have ossification and atheroma of the arteries, or in aged persons, and individuals with atrophy of the brain.

2. Has not the disease of the brain itself (apoplexy), either while impending, or after its occurrence, already produced a change in the state of the blood in those very persons whose blood was examined? This question may the more fairly be asked, considering, on the one side, the important influence exercised by the brain on the formation, or vegetation, of the general mass of the blood; and, on the other, the deficiency of analyses of the blood in different diseases of the brain, with which the blood in apoplexy might be compared.

3. *Œdema of the brain.*—I have already mentioned several of the conditions under which the substance of the brain becomes infiltrated with serum. This occurrence is very frequent, and varies much in degree.

A slight amount of it may be recognised by the unusual

moisture, and the brilliancy of a cut surface of the white substance, while its consistence remains unaltered.

A higher degree is marked by a soft pasty state of the texture of the brain, which becomes loose like pap, manifestly in consequence of infiltration of the tissue with a large quantity of serum. The œdematous white substance has a dull white appearance; in the atrophied brain of an old person it is of a dirty white, or fawn colour.

When œdema reaches its highest degree, it breaks down the texture of the brain into a diffuent watery pap, from which serum escapes in large quantity. This so-called "white softening" (p. 353) is seen mostly in the neighbourhood of the ventricles, and occasionally around tumours and inflamed portions of the organ. In such cases the rest of the brain also partakes of the œdema, though in a less degree.

Edema of the brain may be developed rapidly, and quickly reach an advanced degree, or it may come on gradually and increase slowly. Instances of the former course are best marked in cases of acute hydrocephalus, in the cerebral substance surrounding the ventricles; and, as I have before remarked, it is seen occasionally in the cerebrum, near tumours, spots of inflammation, &c.

Chronic œdema of the brain is a frequent consequence of the most dissimilar chronic diseases, especially of phthisis; whether there be œdema in other parts, or not. It is very common in persons advanced in life, in whose atrophied brain it probably arises from the congestions resulting from vacuum within the skull. And it is equally common in insane persons, accompanying other marks of marasmus of the brain.

Edema generally occupies the brain entirely, but not equally: it diffuses itself from some one spot, diminishing as it advances through the rest of the organ. The substance around the ventricles, when in the state of so-called "white softening," usually forms such a central spot (Concentrationsherd).

The enlargement of the brain to which œdema gives rise reaches its greatest degree when the amount of œdema is considerable, and the brain has lost but little of its volume by previous atrophy. In combination with the inconsiderable effusion which goes on into the ventricles, œdema is very often the principal cause of the swelling of the brain in acute hydrocephalus.

It destroys life, both by the pressure which this swelling exerts, and by the softening and breaking down of the substance of the brain in the spots where it is much advanced.

It is very probable, also, that in advanced age, after having slowly and gradually reached a certain relative degree of intensity, it occasions those common and unexpected deaths which simulate apoplexy.

As a general rule, hemorrhage does not take place in an oedematous brain.

Appendix.—Serous Apoplexy.

In considering the subject of oedema of the brain, a question already several times suggested, has again arisen, as to a mode of death, which is known by the name of "Serous Apoplexy." I have postponed answering it, till a more convenient opportunity; but now, having taken a survey of all the effusions of serum that occur within the cranium, to which, according to the present state of our knowledge, the production of serous apoplexy is, or might be, attributed, we are in a condition to enter into the subject.

The appearances usually mentioned as characterising serous apoplexy are as follow: serous effusion into the sac of the arachnoid (especially a large collection, after the brain is taken out, at the back of the skull); infiltration of the meshes of the pia mater with serum; and a similar effusion between it and that part of the cerebral layer of arachnoid which stretches like a bridge over it; serous effusion into the ventricles; and withal, more or less distinct injection of the vessels of the pia mater with blood. To complete the picture, I must add, that the parenchyma of the brain is also infiltrated with serum. The essence of the whole condition would be an acute exudation of a large quantity of serum produced by congestion, and resulting in palsy of the brain.

The question then is, whether such a disease as serous apoplexy really exist, and whether it can be recognised in the body by the post-mortem appearances only, without reference to the symptoms attending the death of the individual? I would refer, on this subject, to what has been said on the difficulty of the question, at p. 33^f to p. 384, where,

when speaking of a disease similar to this in its final result of paralysing the brain, viz., vascular apoplexy, I mentioned our limited power of determining, by what is found in the body after death, the influence of a disease in producing death (Lethalität). And I would now add that—

a. In the first place, we must exclude from consideration all cases in which hyperæmia originates from any pre-existing disease of the brain, such as inflammations, adventitious products, &c., as well as all acute effusions of serum resulting from them: all cases of hydrocephalus also, all secondary or subordinate (unwesentliche) chronic effusions of serum (those, for instance, which are produced by a vacuum within the cranium), cases of œdema of the brain in old and in insane persons, which destroy life by gradual palsy of the brain, and, lastly, all those effusions, which are proved by daily experience to take place without injuring the brain, and have no evident connection with the death, must be disregarded.

b. As it is a fact that substantive acute effusions of serum within the cranium do occur, their fatal influence will be “*primâ facie*” less doubtful, in proportion to their amount. They may supervene where gradual effusion has been already taking place. Œdema of the lungs presents the closest analogy to them.

c. The great frequency of chronic effusions, and their similarity, render it one of the most difficult of the duties of the pathologist to recognise fatal effusions of this kind, and to determine that serous apoplexy has occurred in any particular case. The present state of our knowledge allows us to assert conscientiously that death has taken place in this manner only,—

When the effusions are considerable in some particular situation, and the membranes and brain are still distinctly vascular:

When the brain is swollen by the œdema; and, especially, when white softening exists in the neighbourhood of the ventricles, but cannot be referred to previous hydrocephalus:

When it is not known that the individual has suffered from a previous affection of the brain:

When the morbid appearances which are frequently associated with it in other organs, especially in the lungs, such, for instance, as hyperæmia, hypostasis, œdema, are nothing but what the

symptoms and the course of the agony show to have been merely consequences of the palsy of the brain, and cannot be looked upon as the actual mode of death, or as the cause of the congestion and exudation of serum within the cavity of the skull.

4. *Inflammation of the brain.*—Inflammation of the brain (encephalitis, the phrenitis of old writers) is not, on the whole, a rare disease, although it is so in comparison with other diseases of the brain; it is seldom found as a primary affection. It never occupies the whole of the brain, but appears in the form of circumscribed spots, which are sometimes very extensive.

It may be acute or chronic; it may produce disorganisation of the brain, and reach its terminations by a rapid or a slower course. Some of its terminations have been most improperly regarded as chronic softening, that, for instance, which Durand-Fardel calls Cellular Infiltration.

When the disease occurs in the white substance, it presents in its various stages and degrees the following anatomical characters.

a. The diseased part is injected, streaked red, and swollen: the bleeding points seen on making a section of it are more numerous than natural, and not unfrequently its surface rises above the level of the incision. At the same time, the cerebral substance is unusually moist, and is already, in some degree, loosened or softened in its texture.

b. If the congestion continue, the redness not only acquires a darker hue, but also gradually discolours almost the whole texture of the part: for, besides being reddened by the injection, it is further discoloured by dots and streaks which are situated outside the vessels, and result from numerous small extravasations into the tissue. Capillary apoplexy, as it is called, is thus found associated with inflammation. The swelling, moistness, and loosening of the texture, are all increased.

c. After this, exudation takes place, and, at the same time, evident modifications of the existing redness. A slightly plastic exudation pervades the cerebral texture uniformly, and, if not mixed with many of the red particles of the blood, it alters the dark redness of the part to a perfectly uniform and somewhat paler colour. Exudations, which contain

a large proportion of coagulable material, are still more remarkable: their coagulable part solidifies in masses of irregular shape and various size, but it is generally found, along the course of the vessels, in streaks or stripes of a yellow and greenish colour. At the same time ruptures of vessels and hemorrhages take place, which are proportioned in number and extent to the violence (tumultuousness) of the process; and the fluid portion of the exudation percolates through the adjoining tissue in the manner before described. Hence there results a colouring, which is composed of several tints, associated and blended in the most different ways;—of dark red, from blood which has been extravasated at different periods; of paler reddening from infiltration of the cerebral tissue with the fluid part of the exudation; of yellow and green from the coagulated fibrin of the exudation; and of white from an occasional piece of cerebral tissue, which has escaped the process. The prevailing colour, however, is the paler red of the cerebral tissue which is pervaded uniformly by the exudation.

At a later period, when this condition has existed for some time, the red colour is further modified, by the colouring matter of both the extravasated and exuded blood gradually changing to a rusty brown, or to the yellow colour of yeast.

d. The process of exudation, moreover, alters the cohesion of the diseased cerebral tissue. At first, as I have remarked, it is softened, but afterwards it becomes entirely disorganised. Its texture is broken up mechanically, partly by the extravasations, but principally by the exudation; and, very probably, it is also dissolved by the exudation. This is the condition for which the usual colour of the diseased spot has procured the name of “Red softening of the Brain;” but the foregoing description of it, which has been drawn from repeated investigations, leaves no question as to its inflammatory nature. The softening is more marked, the greater the quantity of aplastic matter contained in the exudation.

During the stage of exudation (*c*), the inflamed spot might be described, especially by the softening, but further by the following characteristics: the substance of the brain is converted into a pulp, which is red, and variously shaded with dirty violet, brown, and yellow, or of a rusty or yellow colour, like yeast; fragments of healthy brain, coagulated extravasations,

and coagulated fibrinous exudation are scattered through the mass.

When the gray substance is the seat of the process, the anatomical characters are essentially the same; but the great vascularity and looser cohesion of this substance give rise to more of the redness from injection in the first stage, as well as to darker red colouring at later periods: the swelling, and loosening of tissue, the moistness, and the subsequent softening are also more marked.

Upon microscopic examination, the elementary tissues of the brain are seen broken up and dissolved, and amongst them the component elements of the different extravasations and exudations are met with in every stage of their progressive changes, both of degeneration and development. Amongst the latter are found, partially dissolved blood corpuscles, shapeless masses of red, brown, and yellow pigment, single and conglomerate nucleoli in large quantity, globules and crystals of fat, nuclei, primitive cells, &c.

This description has been taken from cases as they ordinarily occur; but inflamed portions of brain are occasionally seen presenting much that differs from it.

α. Sometimes spots are found both in the white substance and in the masses of gray matter, which would be scarcely recognised as spots of inflammation: their nature can be determined only by a close examination, and from their analogy with similar inflammatory processes in other tissues. The redness resulting from injection of the part, is scarcely perceptible; other colouring is still more deficient, and the cerebral substance is loosened and softened to a uniform dull white pulp. On minute examination the texture of the brain is perceived to be broken down, and single and conglomerate nucleoli, nuclei, and pigment-molecules are found scattered throughout it. The inflammatory process, when at a moderate degree of intensity, has led to the effusion of a product containing very little plastic material.

β. Other inflamed spots, again, are found deep in the brain, and especially in the white substance, in which the softening, above described, is wanting, and hardness and resistance are the prominent characteristics. This does not appear to depend upon any induration (sclerosis) of the portion of brain

which is involved in the inflammation, for it has undergone the same destruction when found in this condition as when softened, at least, in that most important particular, the forcible separation and breaking-down of its elementary structures; but its increased consistence arises from the coagulation of highly plastic fibrinous inflammatory products, and of the small extravasations which are present at the same time. The fact of such spots occurring is unquestionable; indeed, it would be surprising if they did not occur. They either go on to suppuration, in which case these coagulated products become converted into pus; or they change gradually into fibroid tissue, and form a cicatrix. In the latter case, there is never any softening throughout the whole course of the process, with the exception of the looseness of the cerebral tissue, that takes place at the beginning.

In the immediate neighbourhood of the diseased spot, a slighter degree of inflammation prevails, and the appearances which it presents illustrate the commencement of the process. This part forms a ready medium for the advance of the disease upon any increase of the inflammatory action.

Changes of much importance occur in the cerebral tissue, still further from the diseased part. They are rarely absent; and thus a gradation of changes exists from the most diseased to the completely healthy structures. The outermost part is generally œdematous, or in a state of yellow softening.

The division of the brain in which the inflammatory process occurs, and, subsequently, even the whole brain, become permanently diseased; and this condition is more marked in proportion to the extent of cerebral substance included in the inflammation. It is forced out of its natural position by the accumulation of the essential, and of accidental, products of inflammation within it; it appears swollen and fluctuating, and presses upon the cranium, and on other parts of the brain, the latter being compressed by it: the convolutions of the cerebrum become flattened, and pressed against one another, and both cerebral substance and membranes are, in consequence, pale and bloodless. The division of the brain in which the inflammation occurs is of course œdematous, and more or less yellow softening surrounds the inflamed part itself, according to its extent, and the intensity of the process going on in it.

The usual site of the inflammation is the cerebrum and cerebellum, the former being affected than the latter. To speak more particularly with somewhat frequently in the white subcortical hemispheres, yet, when we take into consideration in which it happens at the periphery, there is as to the greater liability of the gray substance. In that substance it is found both in the cerebral matter in the corpus striatum and thalamus on the surface of the hemispheres. And this inflammation of the central gray masses and one at the periphery, is, like the same distinct cerebral hemorrhage, a matter of considerable resemblance of the two diseases, in respect to location, though Durand-Fardel endeavours to distinguish the instance of the peripheral substance of the brain.

The inflamed spot varies in size from that of a hazel-nut to that of a fist; it is sometimes as large as almost to occupy one entire hemisphere. In the early stage these large spots are not usually seen, but increase partly by the progressive enlargement of a smaller spot, and partly by several of such spots coalescing. In the latter case considerable softening in a state of yellow softening, usually becomes the diseased mass. The whole then generally assumes the form of a rounded form.

The inflammatory action is generally confined to one spot, though it is not very uncommon to meet with several there are several distinct ones, in the same portions of the brain. Very large spots often consist of the confluence of several smaller ones.

Encephalitis is far from being, as is generally supposed, a very acute disease: in nearly all cases its progress is slow. And this is true, even of traumatic inflammation. If it is the primary cause of death, we may trace the disease to the large extent of brain destroyed, or, as in the case of pressure, to the pressure and anæmia produced by the swelling of the brain, when œdema and yellow softening surround the inflamed spot. It destroys life in a short time, sooner or later, by its terminations and consequences.

of all, by general marasmus, by congestions, especially in the lungs, and hypostatic pneumonia, by sloughs on the sacrum, &c.

a. Encephalitis may terminate in *resolution*, but only at the beginning of the process, and when it is very slight in degree.

b. It results also in *atrophy*,—in secondary atrophy. The principal part of the products of the inflammation is absorbed, together with so much of the injured cerebral tissue in which they are contained, as is incapable of being restored to a healthy condition; while a small portion of the products undergoes a change of structure. This termination is in itself one of great importance; but it also requires more especial notice, because its true character as a termination of inflammation has not hitherto been recognised, and it is looked upon by observers as the true softening, and, indeed, as the highest degree of softening of the brain. (See Andral and others.) In the seat of inflammation we find an extremely delicate, and irregular network, of a white, grayish, or very pale, yellowish-red colour; sometimes it is soft, sometimes pretty firm: its interspaces are filled with a fluid, like an emulsion or limewater, flocculent, white and turbid. Upon minute examination, this delicate network is found to consist of a fine cellular tissue at various stages of development, and of a few vessels. The fluid contains a quantity of separate and conglomerate, elementary corpuscles, fat globules of different sizes, and a little amorphous pigment, which is not discernible by the naked eye. It constitutes the second stage of Durand-Fardel's chronic softening, and is called by him *cellular infiltration*. Both it and the following later stage of the same morbid process occur only in the white matter, or only in those of the cerebral ganglia which contain much white matter. Accordingly I have observed it unquestionably in the corpus striatum, but, like Durand-Fardel, have never discovered it in the peripheral gray matter. Gradually the fluid becomes clearer, and at last we find at the affected spot a cavity, lined by a layer of delicate cellular tissue, and usually honeycombed, or traversed in different directions by slender filaments of cellular tissue, and containing a clear serous fluid. The cerebral substance immediately surrounding the cavity appears slightly condensed,—sclerosis.

Even very extensive inflammations terminate in this manner,

There is no question that the cavity, just spoken of, may gradually diminish, and at length close, like the apoplectic cyst,—for which it is not unfrequently mistaken. The diagnosis between them (which I will mention at once) is often very difficult, and sometimes cannot be made without referring to the early symptoms of the disease. The difficulty arises, on the one hand, from the fact, that high degrees of inflammation are, at first, always complicated with hemorrhage; and, on the other, that inflammation often supervenes upon hemorrhage. The apoplectic cyst generally has its well known rusty-brown or yellowish lining; but it loses, in the course of time, nearly all its colouring matter. The cavity left after inflammation usually has no such lining; but sometimes, when considerable hemorrhages have taken place, the inner membrane of this cavity also is coloured with rusty-brown, or yeast-like, yellow pigment. If a more intense inflammation should have occurred around the seat of hemorrhage in the brain, and produced the so-called cellular infiltration and its consequent cavities, the apoplectic cyst can usually be distinguished in the midst of them, by its coloured lining. It may, however, have almost lost this lining, or the other surrounding cavities may also be coloured with a coating of pigment.

c. Inflammation may terminate in *induration*, *sclerosis*. At the seat of inflammation, there remains a white or dirty-white, rounded, elongated, or irregularly branched cicatrix; or, in a few cases, a callous, grayish, semitransparent substance. The cicatrices which are occasionally found scattered in considerable numbers throughout the brain, in persons subject to convulsions and epilepsy, are most probably examples of the former kind. They consist of a compact mass of elementary molecules, traversed by a few delicate fibrils like cellular tissue. The termination in induration, combined with a growth of fibroid tissue, and condensation, may be noticed around tubercle, abscesses, &c.

d. When the process terminates in *suppuration* and *abscess*, the products of the inflammation become converted into pus; and the other tissues involved in its area, the extravasated blood and cerebral substance, with its vessels, perish (necrosiren) and disappear.

The recent abscess is a rounded cavity, irregularly hollowed

out of the parenchyma of the brain. Its walls are composed of suppurating cerebral tissue, sloughing shreds of which, soaked in pus, hang inward into the cavity, while all around the brain is in a state of inflammation,—of red softening. The more distant cerebral substance is œdematous; and very often the part encompassing the area of red inflammation, is found in a state of yellow softening, which has occasioned death. The diseased division of the brain, and sometimes the entire organ, is swollen, anæmic, fluctuating, &c., in degrees proportioned to the size of the inflamed spot, and the activity of the processes going on around it. The pus contained in the abscess is thick and greenish, and has an extremely fetid phosphorescent odour.

By continued inflammation and suppuration, the abscess advances beyond the bounds of the original inflammation. Sometimes it enlarges uniformly on all sides; but it generally does so in one direction only, and in the form of a sinus.

When an abscess thus enlarges, and the process of ulcerative inflammation extends to other structures, such as the membranes of the brain, the cranium, &c. an outlet may be formed, and the matter discharged. It is, however, a necessary condition, that the inflammation of the inner membranes be limited, and do not spread out into an extensive meningitis. Such outlets may be formed at various parts of the skull, and the matter be discharged either directly outwards, or into natural cavities and canals, which convey it away. In this manner pus is discharged from an abscess of the brain, through the cribriform plate of the ethmoid bone into the labyrinth and cavities of the nose, or through the tympanum and meatus auditorius externus. In the latter case, the roof of the tympanum or the wall of the mastoid cells is destroyed by caries, and the matter finds its way into the tympanum; from whence, after ulceration of the membrana tympani, it is discharged. Such a purulent discharge bears the name of *otorrhœa cerebialis*, inasmuch as the matter, though coming out at the ear, proceeds, in part at least, and for some time, from the brain. Albers considers that the priority of the affections of the brain and ear may be reversed, and sometimes one, sometimes the other, may be the original disease: while, in a third case, both may arise together, from a common cause.

The rupture of an abscess of the brain into the ventricles is always rapidly fatal.

Although abscess in the brain is usually fatal, yet patients very often live on with it for a considerable period, and sometimes without presenting any clear evidence of its existence. In such a case the abscess has become encysted, and is even capable of being completely healed.

* The abscess becomes enclosed in a firm capsule, by the conversion of the granulating layer on its inner surface into a dense, cellulo-fibrous (fibroid) membrane, while the adjoining layer of cerebral substance becomes condensed, and like a cicatrix.

The inflammatory process may be renewed in the walls of an encysted abscess; or œdema, or yellow softening, may take place in its neighbourhood, and, in either way, death very frequently ensues. But, as I have said, the abscess may heal. The pus is then partly absorbed, the remainder of it becomes inspissated, and forms a chalky residuum; and the capsule enclosing it contracts equally, and at length altogether wastes.

Every inflammation of the brain may terminate in suppuration; but it is more especially those inflammations which are produced by wounds, and concussion of the brain, that take this course.

The destruction of brain, and the loss of its substance resulting from the inflammatory process, give rise to a remarkable consequence. The nerve-fibres which are involved in the inflamed spot become atrophied, more or less plainly, according to circumstances. And, after repeated attacks of inflammation, the whole brain becomes also tough and wasted, in the same manner as after the frequent occurrence of cerebral hemorrhage.

Encephalitis may be a spontaneous disease, or it may come on as a traumatic affection from a wound, or concussion of the brain. In the former case, it is sometimes the primary disease; but very frequently it is secondary, or consecutive. Thus it is often developed in the neighbourhood of malignant deposits, around the bed of hydatids, or about foreign bodies which have lain for an indefinite period in the brain without producing injury, &c. When it happens as the primary disease, it is very frequent in persons advanced in life, and in the aged; it

is, however, far from being peculiar to them; no period of life, not even childhood, is exempt from it, and I have unquestionably observed it in the immature fœtus. It seems to depend, principally, upon a liability to passive congestions, for it is common in old and much reduced persons, and is not uncommon in the period of debility following the exhausting acute dyscrasiæ, especially typhus. Hypertrophy, or dilatation of the heart, is not unfrequently also present, and may favour the production of the disease.

After these remarks on encephalitis in general, some special notice is required of inflammation of the periphery of the brain. The same reasons which make peripheral apoplexy important, render this so too; and, indeed, peripheral inflammation is, if possible, the more serious, from its not unfrequently occupying a great part or even the whole of a hemisphere, and often giving rise to secondary imbecility.

It presents the same general appearances as inflammation of the gray matter elsewhere. Even when slight in degree, and when but just commencing, it may be clearly recognised, on exposing the surface of the brain, by the dark red colouring and swollen state of the inflamed part, and by large pieces of cerebral substance adhering to the pia mater, and coming away when the membranes are peeled off. Higher degrees of it are generally combined with inflammation of the pia mater itself; and sometimes it is not confined to the peripheral substance of the brain, but it involves also the pia mater, the arachnoid, the dura mater, and even the cranium, as is proved by the adhesions formed between those different structures, and by their increase in size.

Peripheral encephalitis is mostly situated in the gray substance of the convolutions on the convexity of the cerebral hemispheres; it is less frequent at the base, and still less on the cerebellum. It is also generally remarkable for its great extent.

Peripheral inflammation terminates in *resolution*, or in a state of *looseness* of the outer layer of the cineritious structure, in which it clings to, and may be stripped off with, the pia mater.

Or it may terminate in *atrophy*, and *absorption*. The cineritious layer then becomes thinner, and either whitened, or of a dirty fawn or yellow colour; or else it is completely

removed, and then the white substratum of the convolutions is laid bare, and appears condensed and callous. My observations correspond with those of Durand-Fardel, in having never found in the periphery of the brain, that condition of parts which he has named cellular infiltration.

The last termination of the disease is *induration*. The convolutions are found tough and callous through their whole thickness; they are also paler than natural; and the pia mater covering them, having become condensed and tendinous, adheres closely to their surface.

I have already spoken, (at p. 394) of the so-called yellow plates, which Durand-Fardel attributes to chronic softening of the surface of the brain, and of the ulceration, as it is called, of the surface of the brain, which is associated with it. The former are the remains of the extravasation: and the so-called ulceration is produced by absorption of so much of the substance of the brain as had been broken up by the hemorrhage. Both appearances certainly may be found combined with some remains of inflammation, especially with cellular infiltration in the adjoining white substance.

A later and a most important consequence of these terminations of peripheral inflammation is a gradual *atrophy* in the interior of the brain, which, when the original process has been very extensive, involves the entire hemisphere. It is accompanied by induration and a dirty-white discoloration of the fibrous substance. These appearances are sometimes so marked that the whole disease might be taken for an original and congenital arrest of development; and the more uniformly the several parts of the hemisphere are wasted, the more likely is the mistake. Moreover, the atrophy is usually concentric, so that the lateral ventricle is diminished in size. The vacuum is filled up by thickening of the membranes, and an effusion of serum around the hemisphere; and in the case of the cerebrum, by an enlargement of the opposite hemisphere, which is due to the dilatation of its lateral ventricle.

5. *Metastases*.—In some cases, in which the blood is poisoned by containing a large quantity of purulent matter, as, for instance, in the purulent diathesis, or pyæmia, of lying-in women, the brain becomes the seat of metastatic purulent deposits. Under these circumstances, other organs and tissues

are always found to have undergone the same morbid process. A marked characteristic of these deposits in the brain is their great number. They occur in all parts of the organ; but they are most commonly found deep in the substance of the cerebral hemispheres. As in other parts of the body, they are developed from a circumscribed dark-red plug or core, and they form collections of pus or of ichor, the usual size of which ranges between that of hempseed or a pea and that of a bean.

6. *Softening of the brain.*—The most prominent feature of softening of the brain, or encephalomalacia, is the alteration of consistence: but the disease results from other fundamental changes, and is treated of amongst the diseases of texture only for want of a more suitable place. Our previous investigation of certain examples of softening will have prepared us for the consideration of the whole subject, and we shall now, with regard to them, be referring only to what has been already asserted.

Notwithstanding the labours of many older and more recent observers, the anatomical diagnosis of softening of the brain is far from being either clear or complete. Without doubt, this deficiency has principally arisen from their neglecting to distinguish accurately the several forms of the disease. And it has been needed also that observations should be extended to analogous processes in other organs, especially to inflammation, and to that softening, disruption, and solution of tissue which characterises inflammation wherever it occurs, as well as to its terminations in other structures also. Moreover, the disease has, from want of material, been insufficiently observed in its several stages; and, lastly, a lack of special observations supported by chemistry, especially of observations on yellow softening, has contributed to the same result.

Softening of the brain occurs under such totally different forms that it cannot be treated of as one general disease. For the same reason it is impossible to decide the question, whether it be of inflammatory nature, that is, produced by inflammation or not; a question which is answered in the affirmative by one large party, and in the negative by another equally large.

There are three essentially different forms of softening of the brain: two of them have been already spoken of; but, in order to complete the account of the disease, they must be again brought forward.

a. The first form is that which is met with in hydrocephalus (p. 353), and œdema of the brain (p. 403), as *white*, or hydrocephalic softening. It consists in a loosening and subsequent laceration of the cerebral texture by an interstitial exudation of serum. Like œdema in general, it sometimes takes place without any inflammation, at other times it is unquestionably so far inflammatory that a certain quantity of a coagulable blastema, capable of assuming an elementary organisation, is poured out with the serum. Examples of it are furnished in the more or less acute forms of œdema, which occur in the neighbourhood of spots of inflammation, and more especially in the œdema, which accompanies acute meningitic hydrocephalus, and destroys the tissues around the ventricles of the brain. In such cases of softening, the characteristic products of inflammation may generally be discovered with the microscope in the diffuent cerebral mass.

It does not appear to me necessary to suppose (with Paterson), that the brain is naturally hygrometric, in order to explain the occurrence of such a softening in the neighbourhood of the ventricles, in cases of acute hydrocephalus; I have made frequent experiments, but have never found imbibition to produce a softening of the cerebral tissue, in any way resembling that which takes place in hydrocephalus.

Nor can I adopt Fremy's view (which will be taken into consideration, together with the subject of yellow softening). For white softening has, apparently at least, no connection whatever with putrefaction, and it is certain that it often exists for a long period as chronic œdema of the brain, and yet the serum is found to have caused no maceration or decomposition of the cerebral substance.

It is quite different from yellow softening, and has no analogy whatever with the process of softening in the stomach.

Its essential character, viz. that of destroying the cohesion of the brain, was recognised by Laennec.

b. The second form is that which has been described in the article on Inflammation, as *red* softening (p. 407), and in some few cases as a softening, marked by *dull white* discoloration (p. 408). There can be no doubt of its inflammatory nature; and in the trifling amount of the discoloration, i. e. the whiteness of the softened tissue, the latter variety

shows its alliance to inflammatory œdema. The softening results from the cerebral tissue being broken asunder and dissolved by the exudation.

This class includes, moreover, that condition which has been described (p. 411) as a termination of inflammation of the brain, as the termination in atrophy or absorption, or the so-called cellular infiltration.

All these softenings are found, as has been noticed in the separate descriptions of them, not only as primary and substantive, but also as secondary and symptomatic.

c. The third form is the *yellow* softening, which has hitherto been only occasionally mentioned. It is on every account a remarkable disease of the brain, and yet, singularly enough, it has received but little attention from observers until very recently, and is only cursorily mentioned by them: it is, however, the instance of softening that best supports the numerous opinions of German and French physicians, who oppose the theory of its being of an inflammatory nature, especially those opinions according to which it is a disease *sui generis*, a specific alteration of nutrition, &c.

Yellow softening, like inflammation, never attacks the whole brain at once, but occurs as a primary and idiopathic disease in pretty sharply circumscribed spots.

At a spot which may vary in size, but which is scarcely ever larger than a hen's egg, the cerebral substance appears converted into a very moist, tremulous pulp, of the yellow colour of straw, or sulphur, and not unlike brine (*sulzeähnlich*): when cut across it rises considerably above the level of the section; and it presents to the naked eye no trace of natural cerebral structure. The transition from the diseased to healthy structure is somewhat abrupt, passing through a thin layer of cerebral substance in which the disease is less advanced; the texture of the brain immediately around is found to be comparatively normal.

These are the appearances in a well-marked case; but there are different degrees of the affection, as may be seen in the immediate neighbourhood of a part which is thoroughly disorganised. They are distinguished by the different amounts of discoloration, *i. e.* of saturation with colour, and by the degree in which the texture is infiltrated and disorganised.

the pons and the other structures at the base of the brain. It attacks both the fibrous structure and the central masses of gray matter, but it is extremely rare in the periphery of the brain, and when it does occur there, is almost always secondary. There is no essential anatomical difference between yellow softening of the gray matter and that of the white.

The affected spot varies in size from that of a bean to that of a walnut or a hen's egg: I have as yet seen no examples of primary and uncomplicated yellow softening which exceeded those dimensions. There is generally only one spot, and its shape is round.

Yellow softening is met with, both as a primitive idiopathic disease, and as secondary and symptomatic. The foregoing remarks apply principally to the former kind. The latter is the more frequent. It accompanies inflammation, hemorrhage, and adventitious products of the most different kinds in the brain, affecting the cerebral substance immediately around them. In cases of inflammation, it not only encircles the diseased spot, but is seen also at different parts in its interior; for the portions of cerebral tissue which sometimes remain uninjured within large areas of inflammation may afterwards be attacked with yellow softening.

It is sometimes noticed in the neighbourhood of the ventricles, forming the central spot from whence acute œdema radiates in cases of acute hydrocephalus.

The cerebral substance immediately around an apoplectic clot, or adventitious product, is occasionally found in a state of yellow softening; but far more commonly there is an interspace of inflamed tissue (red softening) between the central disease and the yellow softening.

The diseases of the brain which have just been mentioned are the usual pre-existing and the most important diseases with which yellow softening is found combined.

Yellow softening appears to be always and rapidly fatal; and, in those diseases of the brain which have been mentioned, it is in fact the immediate cause of the fatal result. According to my observations it runs a rapid course, especially in its secondary form, though no doubt cases of idiopathic yellow softening may last for a longer time. There does not appear, *à priori*, to be any reason why these spots should not heal;

they might do so in the same manner as the apoplectic cyst, or inflammation; but, as yet, we have no facts to prove it.

Yellow softening, primary as well as secondary, may occur at any period of life; but, under both its forms, it is most common in middle and advanced age.

Its nature is still quite problematical.

It has been remarked above, that in a slight degree of softening, a thin yellow fluid oozes from the diseased portion of brain. This fluid, on minute investigation, presents a number of broken, extremely varicose, primary tubes, with their contents, of swollen blood-globules, very transparent fat-globules of various size, and some yellow amorphous pigment. I have repeatedly tested the fluid, and been convinced that it is somewhat intensely acid.

The first question which arises is, whether yellow softening be of inflammatory origin. The following points must be considered in the attempt to solve it.

a. At no stage of the primary form of the disease, from the earliest period at which it can be recognised as yellow softening, is any injection or reddening perceptible; nor is there any vascularity worthy of notice in the parts adjoining or more distant from it, if we except the congestions, which, from the existing œdema, we may infer to have previously taken place.

b. The same remark applies to the secondary softening. This form either immediately surrounds a spot of apoplexy or an adventitious product (in which case, as in the primary, it is entirely free from vascularity and reddening); or it skirts a spot of inflammation, or some inflamed cerebral substance which itself surrounds an apoplectic spot or adventitious product. The line of boundary between the inflammation and the softening is, however, sharply defined, and no injection or reddening extends beyond it into the region of the latter. It may even surround the rarer kind of dull white inflammation.

c. It does not contain those products and elementary formations which are usually found in inflammation.

d. The yellow colour is certainly not dependent on the presence of pus and pus-cells; nor is the proper colour of the fluid that of pus: it acquires its yellow puriform tint from being mixed with cerebral tissue.

The theory, therefore, which ascribes the origin of yellow softening to inflammation appears to be quite untenable.

Blood corpuscles, and the pigment already alluded to, have as little to do with the production of the yellow colour as purulent matter. Especial care must be taken not to commit the common error of confounding the colour of yellow softening with the rusty-, yeast-, or ochre-yellow tints of the cerebral substance in cases of apoplexy and inflammation, which undoubtedly depend on the colouring matter of the blood. The colour in yellow softening entirely differs from these; and, indeed, cannot arise solely from the colouring of the blood, for the fluid contains far too small a quantity of blood-corpuscles, as well as of the amorphous pigment, to account for it.

It is remarkable, that yellow softening of the brain never gives rise to any inflammatory reaction around it.

My own impression is, that yellow softening is founded in a chemico-pathological process.

As Couerbe's view, which was suggested by the equivalence in composition, or the isomerism, of the *Eléencéphol* of the brain with another of its constituents, the *Céphalote*,¹—a view which was adopted by Majendie,—must be rejected as a mere ingenious combination; so neither can Fremy's theory be accepted, which was drawn from the process of putrefaction in the brain. But it must be admitted that, whilst yellow softening does not exhibit the remotest similarity to the decomposition of the cerebral substance in the putrefactive process, much use may be made of Fremy's views, and that they have given a direction to future investigation which is full of promise.

He considers the brain to consist of cerebrie acid, either free or combined with soda and phosphate of lime, of oleo-phosphoric acid, free and in combination with soda, of olein and margarin, of small quantities of oleic and margaric acids, of cholesterine, water, and a substance like white of egg, in the proportion of 7 parts of albumen, 5 of fatty matters, and 80 of water. The oleo-phosphoric acid, which, like the olein, is usually yellow, is very easily acted on (*sehr veränderlich*), and separates readily under slight influences into phosphoric acid and olein. Thus it decomposes at an ordinary temperature, when it comes into contact with water; and decomposing animal matters give

¹ [See Majendie's *Léçons Orales*, t. i, p. 159.—ED.]

rise to a similar change in it. Now, putrefaction of the brain is this decomposition of phosphoric acid. But the process does not decompose albuminous matter, also decomposing, sets in position in the olein, and genuine saponification, a conversion into oleic acid, and a combination with ammonia. Fremy thinks that this is the process on in softening of the brain,—that it is putrefaction of the brain. Although, as I cannot discover any of the phenomena of the process of yellow softening, yet the liberation of phosphoric, and especially one or more of the acids, may be conjectured to be one of the most important changes in yellow softening. The conjecture is supported by the acid reaction of the fluid contained in the softened brain.

A second question which arises has to do with the proximate palpable cause of the process. In commonly yellow softening occurs both as a result of inflammation, and in those portions of brain not injured by the exudation, that it is also the halo of inflammation which surrounds the growths, and even immediately around these. We may infer that obstruction of the vessels, or impermeability of them from pressure, or frequent impeding and interruption of the circulation of the portion of the brain, may be one of the causes. And then, under certain circumstances, of the cerebral tissue with extravasated blood, and stages of metamorphosis, and with the pressure, might give the first impulse to the softening.

It appears, then, that yellow softening, and the examples of softening of the brain, may be compared with softening of the stomach. In both the possibility of any inflammatory reaction in the brain is absolutely precluded.

7. *Induration of the brain—Sclerosis.*—The brain is liable to increase under various circumstances, and in every degree, from that which is called induration, to that of a leather-like or fibro-cartilaginous

ance. In the slighter degrees, there is no evident or decided anomaly, and it is most probable that they mainly depend on a diminution of the quantity of water in the brain; but in decided cases it arises from atrophy, shrinking, and change of structure. The more important indurations, therefore, must be classed among the diseases of the texture of the brain.

Induration is either total or partial: it affects the whole brain equally, or some single, larger or smaller, part of it only. The partial indurations are generally distinguished for the great degree of hardness they attain, and are known as a callous state or cicatrix of the brain.

The minor degrees of increased consistence, that, for instance, which is commonly selected for the study of the fibrous arrangement of the brain, are best marked after great and exhausting exudative processes, such as peritoneal exudations in puerperal women, or in the course of ileo-typhus, typhoid fever, and acute exanthemata, especially of scarlatina. And here, in opposition to Gluge, I must expressly state, that such a degree of condensation of the brain is the rule in typhus; while, on the other hand, decided softening, which, in fact, is nothing more than œdema of the brain, is certainly common later in the disease, in the train of evils connected with the disordered state of the system, which follow typhus.

In poisoning by sulphuric acid (Otto), though I have had abundant experience, I have met with no instance in which the consistence of the brain was increased. In poisoning with lead, on the contrary (Andral, Tanquerel), though the consistence of the organ was sometimes increased, and, in a few cases, a high degree of it was combined with shrinking of the brain, there was much more commonly an unnatural softening resulting from œdema.

More advanced degrees of increased consistence, those in which the cerebral mass becomes tough like leather, accompany atrophies of the brain, as well those which are total, as, and more particularly, those which are partial. The most marked example of them is that which attends the partial atrophies resulting from a previous change of texture, apoplexy, or inflammation (p. 380). In such examples, circumscribed dense cicatrices are found in the parenchyma of the brain.

Induration in its highest degrees presents a fibrous, cartila-

ginous, or scirrhous hardness, and results from a serious disease of texture, especially from infiltration of the cerebral substance with cancerous matter. The disorganised portion of brain appears to have nearly or entirely lost its natural texture; and, in the latter case, the cerebral substance at length disappears in the foreign mass. (Compare "Cancer of the Brain.")

8. *Adventitious growths*.—Although there are some forms of adventitious products which are rarely seen in the brain, yet there are others which are comparatively frequent: so that this class, on the whole, supplies an average number of the diseases of the organ. Among the most frequent are tubercle and cancer.

Their importance is proportioned to their size, to the vascularity and looseness of their texture, and their consequent liability to swell, to the rapidity of their growth, to the degree in which they give rise to congestions in their own immediate neighbourhood, or in the whole brain, whether it be by acting as foreign bodies, or in consequence of the change of material going on in them, &c. They lead to displacement of the brain and pressure; and thus interfering with the injection of its vessels, they produce anæmia in it; they cause congestions also, and swelling of the organ, and finally hypertrophy, œdema of the brain, and hydrocephalus, inflammation and yellow softening in the neighbourhood, &c. And so death occurs, sometimes gradually, at other times in a rapid and unexpected manner.

a. Fatty tumours.—This disease is very rare in the brain: when it does occur it will be found to spring rather from the tissue of the pia mater, and lining membrane of the ventricle than from the cerebral substance. This is especially true of the genuine lipoma. Examples of encysted cholesteatoma (adipocire-like tumours) are also met with.

b. Cysts.—Though these growths are rare, they are less so than the lipoma; the only form in which they occur is that of the sac of the acephalocyst. The mother-sac of acephalocysts in the brain generally has such remarkably thin coats, that it may be easily overlooked; and a single acephalocyst, when it completely fills the mother-sac, might readily be regarded as the sac itself. The cases which I have met with have all been of that kind, namely, a mother-sac, completely filled with a single acephalocyst. Other observers have seen

cases in which the acephalocysts were more numerous, and different museums contain examples of them.

Neither simple nor compound cysts seem ever to be formed in the brain.

c. Fibroid structures.—Tissues of this kind, as well as newly-formed cellular tissue, are met with in various stages of development, in apoplectic and inflammatory spots, in the wall of the apoplectic cyst, and of a healing inflammatory spot, and in their cicatrices, in the membranous wall of an abscess, or of a tuberculous cavern in the brain, in the capsules of many of the adventitious products, &c.

Fibrous tumours are very seldom found in the brain: there are many cancerous growths which bear a deceptive likeness to them, and which are very commonly mistaken for fibroid growths.

d. Chalky concretions.—These concretions are found in the form of circumscribed accumulations of a dull white chalky powder, or of a yellow mortar-like, or coherent solid mass. They are generally enclosed in a cyst, which may be thin or thick. They consist essentially of the thickened and cretified contents of an abscess, of cretified tubercle, of the chalky contents of the bag of a dead cysticercus, or the like.

e. Tuberculosis.—Tubercle is the most common of the adventitious products in the brain, and it is frequent in comparison with other diseases. Tuberculosis presents several peculiarities in the brain.

The *number* of tubercles is usually very small, one or two being met with in most cases, and more rarely three, four, five, or a few more; some extremely rare exceptions do occur, in which twenty and more are found. When there is a small number of tubercles, each separate one acquires a considerable size; but when they are more numerous, no single one becomes much larger than a hemp-seed or pea. There is also a further difference between tubercles in the brain and those in other organs, that the former are usually found not aggregated together, but widely apart from each other.

Tubercle in the brain generally attains a considerable *size*, and is larger in proportion as the number of deposits is small. Its volume varies from that of a millet-seed to that of a hen's egg, or more; the most usual size is that of a hazel-nut or walnut.

It appears, therefore, that tubercle in the brain presents

fact, in course of conversion into a fibroid callus. Outside this layer an extremely delicate moist and jelly-like cellular structure connects the tubercle with the surrounding cerebral tissue; but its texture is so slight that the whole morbid mass may be easily loosened and turned out of the brain. This stratum further contains, scattered mostly through its inner part, some small gray or grayish-yellow tubercles, which occasionally unite with the great central mass. Although this cellular stratum surrounding genuine tubercle in the brain, is sometimes very thin, yet it is scarcely ever absent; it is the product of a moderate inflammatory process tending to induration, and corresponds to the like process which occurs around large masses of tubercle in other tissues.

As tubercle in the brain is generally discovered in the form depicted above, bearing marks of a previous process of softening, it may be asked whether it has no crude stage in that organ, that is, a stage of gray translucent granulation, or whether it is at once secreted as the yellow lardaceous, or cheesy tubercle. There are some rare cases which prove that tubercle in the brain does, in part at least, commence in the gray translucid form, for portions of a tubercular mass are sometimes found in that state. In any case, however, it may continue for a short period only in that form, and soon pass into the stage of the yellow cheesy tubercle.

Tubercle is usually fatal when it occurs in the brain, before the further changes of which it is susceptible, viz. softening and cretification, can occur. The former, however, is not extremely rare. When the tubercle is entirely *softened*, its place is found occupied by a cavern, mostly of a spherical form, which is enclosed in the peripheral vascular reddish stratum before described, and has the characters of an encysted abscess. The interior of this stratum is in a state of suppuration; and sometimes secondary deposits of tubercle, which may also soften, are found in it. As, after some time, the early characters of the tubercular matter may disappear, it is often very difficult to distinguish the abscess which has originated in tubercle, from that which has resulted from inflammation; and it is only by the concurrence of tuberculosis in other parts, and more especially in the brain, that the diagnosis can be rendered certain.

Cretification of a tubercle in the brain is one of the most

uncommon metamorphoses which tubercle ever undergoes; but yet it does occur in some cases, not only in one, but even in several extensive tubercles.

Tuberculosis is a chronic affection in the brain. An acute form of the disease is unknown in that organ.

Brain-tubercle, as well as tubercular abscess, may exist for a long time before the changes which it occasions, either in the whole brain, or in the adjoining cerebral substance lead slowly or rapidly to a fatal termination. A general description of these changes is given in the Introduction.

It must also be remarked that death may ensue from inflammation of the membranes with tubercular exudation, and from acute tuberculosis of the membranes at the base of the cerebrum, combined with acute hydrocephalus. Both these are processes which originate in tuberculosis of the brain.

Tubercle in the brain, like tubercle generally, may occur at any period of life; but it is notorious that in this situation it is especially a disease of childhood and youth. In some very rare cases it is the only instance of tubercle in the organism, but, as a rule, it is combined with tuberculosis of other structures. Its most frequent combination is with tuberculosis of the absorbent glands, which prevails most at the same period of life. Next in order of frequency to the glands, is its association with tubercle in the lungs.

f. Cancer of the brain.—There is no organ in which growths of a cancerous nature occur in such number, and in such variety of internal elementary structure, as in the brain. I must refer the reader on this subject to the general remarks on cancer, and the morbid products allied to it.

They are met with either infiltrated through the cerebral substance, so that the transition from diseased to healthy structure is gradual and insensible; or, as is far more common, in the form of an independent and abruptly circumscribed tumour, which is enclosed in a delicate areolar and vascular investment.

The infiltrated cancer generally involves a very considerable portion of the brain, while the tumours attain various dimensions; sometimes equalling a hen's egg in size, sometimes exceeding the fist. They are generally spherical; but when their texture is soft, they readily accommodate themselves to any firm

adjoining structure; and those even which are dense and tough, when situated at the periphery of the brain, become flattened on their surface, or excavated like a navel. They sometimes advance from the brain to the membranes, and through them to the cranium.

The infiltrations sometimes render the diseased portion of brain tough and firm, like a cicatrix. (Sclerosis.)

Highly vascular adventitious growths are particularly serious, from their liability to swell.

Cancer of the brain very often occurs quite alone in the organism; but medullary cancer, and melanosis, amongst others, are usually associated with cancer in other organs, or with a general development of cancer.

Lastly, there is usually but one adventitious growth in the brain; but when there are two, it is interesting to notice, that they not uncommonly occur symmetrically in corresponding portions of the brain.

g. Entozoa.—The acephalocyst, with its inhabitant, the Echinococcus, and the Cysticercus cellulosæ are pretty frequently found in the brain. There are often some few only of one or the other, while in some rarer instances they abound in almost countless numbers. In the former case they are usually confined to the brain, in the latter the muscles also are often crowded with them.

They occupy the gray substance almost exclusively, selecting the peripheral much more than the central masses of it. When situated at the surface of the brain, they mostly project beyond its level, and become partially imbedded in the tissue of the pia mater.

Should the animal die, the cyst becomes thickened and shrunk, and its contents inspissated, and at last chalky; so that a chalky concretion is afterwards found enclosed in a fibrous bag. It is very difficult to distinguish between this and cretified tubercle, and the diagnosis can be established only by the presence of other living animals.

APPENDIX.

DISEASES OF THE CEREBRAL APPENDAGES. (HYPOPHYSES.)

THE PITUITARY GLAND.

THE pituitary gland is far more frequently the subject of disease than the other hypophysis. Morbid processes, especially those which are deeply seated, have their site in its anterior vascular lobe.

§ 1. *Anomalies in Size.*—Increase in the volume of the pituitary gland may result from congestion, inflammatory swelling, and abscess, or from the presence of an adventitious growth. I have never observed any actual hypertrophy of the gland.

Atrophy, on the contrary, is not unfrequent. It accompanies, in old persons, the same affection of the brain. It prevails especially in the posterior lobe, which, besides diminishing in size, becomes loosened and pulpy (softened), and discoloured to rusty brown, or yeast-yellow. At the same time the anterior lobe becomes pale, withered, and tough. Moreover atrophy is sometimes produced, in cases of chronic dropsy of the ventricles, by the pressure which is exerted upon the gland by the serous effusions, through the medium of the third ventricle.

The infundibulum, in like manner, usually shares in the atrophy, and becomes pale, withered, and thin.

§ 2. *Diseases of Texture.*

1. *Hyperæmia.*—Congestion of the pituitary gland is generally combined with the like condition of the pia mater; but in young persons it is occasionally observed alone. It occupies the anterior vascular lobe, and the infundibulum. The cluster of vessels descending on either side of the latter, to the gland, is injected, the substance of the infundibulum is redder than natural, and the turgid gland is loose in its texture, dark red, and full of blood. In some very rare instances the congestion leads to apoplectic extravasation. I have observed small streaks of it associated with congestion of the membranes.

The gland is anæmic in cases of anæmia of the membranes.

2. *Inflammation*.—This process also, so far as I am aware, is confined to the anterior lobe. The appearances which distinguish it are swelling, dark reddening, and looseness of the texture of the gland, but more particularly exudation. This last is usually a yellow, fibrinous product, with small points of which the gland is dotted; or which collects in spots, of the size of millet- or hemp-seed, or runs together into larger masses. Suppuration may take place in these masses, and give rise to abscess of the gland; and this, by the advance of the inflammation in the adjoining parts, may enlarge, and attain a considerable bulk. I have seen cysts of this kind, from the size of a hemp-seed to that of a hazel-nut. If the inflammation in the adjoining parts terminate in callous induration, the abscess becomes encysted.

3. *Adventitious growths*.—The diseases of this class which I have observed in the gland, are tubercle and cancer.

a. *Tuberculosis* of the gland is, on the whole, a rare disease. It occurs only in combination with tubercle in other organs, especially in the lungs and brain. It assumes both the form of gray crude granulation, and that of a mass of yellow tubercle, which softens and suppurates.

β. *Cancerous* productions are proportionally more numerous; indeed they are the most common of all the important diseases of the organ. In every instance which I have observed, the growth was of the medullary kind. In one case, in particular, it was a lobulated encephaloid, of a loose, creamy structure, enclosed in a fibrous (neurilemmatous) cyst.—In a second case, it was a vascular, reddish-brown, and elastic, but firm medullary growth; while, in a third case, a similar growth was found, degenerated into a brown, chocolate-coloured fluid, and contained in a neurilemmatous sac, which projected into the pharynx through an opening it had formed in the base of the skull, by destroying the body and part of the greater wing of the sphenoid bone. In several cases the growth had reached a considerable size, and the base of the skull was destroyed, and the brain displaced upward and laterally, to a corresponding and very marked extent.

The growth in this gland was, in several cases, the only example of the disease in the body; whilst in others, on the

contrary, it was associated with cancerous organs.

γ. In conclusion, there is a morbid to the class of adventitious production a gummy or glutinous (colloid) substance like citron or yellow wine, and occupies between the two lobes of the gland. If be made, dividing both lobes in half, this to form a layer between them, from a q line in thickness, and sometimes to force

The growth in question has acquired brothers Wenzel having asserted that i epilepsy. I have made frequent examining with reference to this assertion; but have to discover the disease in those who had from epilepsy and convulsions, as I have individuals who had been thoroughly healt

THE PINEAL GLAND.

The pineal gland is rarely the subject in a general point of view, but even in c pituitary gland. Its affections are also slight. They are confined to—

1. The production of the yellow sand (ac an age (the proper date is fixed by Sömr and its existence in great quantity, or masses; and,

2. Enlargement of the cavity of the g conversion into a membranous sac as la hazel-nut, or even still larger. There cases, a large quantity of sand scattered in it is accumulated near the peduncles, w remains parenchymatous, and it gives the cy of being ossified. This change is always certain degree of chronic hydrocephalus, an the lining membrane of the ventricle.

CHAPTER II.

THE SPINAL CORD.

SECTION I.—ANOMALIES AND DISEASES OF THE MEMBRANES OF THE SPINAL CORD.

OF THE DURA MATER OF THE SPINAL CORD.

§ 1. The fibrous investment, and the other membranes of the spinal cord, are but partially developed, or are not developed at all, in cases of acephalus, in which, at the same time, the spinal cord is wanting (amyelia).

§ 2. The principal deviation from the natural size and form of the dura mater is the saccular dilatation met with in partial spina bifida—hydrorachis, of which I shall have to speak hereafter.

§ 3. Its continuity is broken not only by penetrating bodies from without, and by fragments of the vertebræ, when they are fractured and comminuted,—by either of which it may be wounded in various ways,—but also from other causes. Thus we find various openings in it: in cases of extensive spina bifida (atelomyelia of Bèclard), it is deficient at its posterior part. It may be lacerated in the cervical region by the odontoid process of the axis, whenever, in consequence of inflammation and suppuration of the ligaments, and of caries, that vertebra is dislocated. Ulcerated openings form in it from the pressure of abscesses, and particularly of those abscesses which are connected with caries of the ribs and vertebræ, &c.

§ 4. *Diseases of its Texture.*

1. *Inflammation.*—Inflammation of the spinal dura mater occurs as a consequence of accidental injuries, and is propagated from adjoining inflamed and suppurating tissues, such as

ligaments and bone; but it does not arise from any other cause. Its characters are those of inflammation of fibrous tissue in general; and when it extends more deeply, it gives rise further to circumscribed exudation on the inner free surface of the membrane. If the conditions under which it originated do not destroy life too soon, either by the pressure of the swollen vertebræ on the spinal cord, by spontaneous dislocation of the vertebræ, and laceration of the cord, or otherwise, the inflammation may reach its natural terminations. In those cases in which the inflammation of the bone and the caries heal, the dura mater continues permanently thickened, and adherent to the bone, and even to the visceral layer of the arachnoid also. In other cases, the inflammation of the dura mater terminates in suppuration and perforating ulcer. It may thereupon extend, as a circumscribed inflammation, to the inner membranes, and to the cord itself, or may spread out into a general spinal meningitis.

2. *Adventitious growths.*—They are mainly confined to cancerous growths.

a. *Cancer* of the fibrous spinal membrane, known as *fungus duræ matris spinalis*, resembles, in its general characters, the fungus of the dura mater of the brain. It may be a primary disease, or the membrane may degenerate secondarily in consequence of being involved in cancer of the vertebræ, and especially of the bodies of those bones. It generally grows exuberantly over a considerable extent of the surface of the membrane, either on its outer or inner side: and as, in the latter case, the arachnoid is destroyed by the advancing growth, the canal of the dura mater is sometimes entirely filled up. Not unfrequently, when it springs from the bones, it involves principally the fibrous sheaths of the nerves and their ganglia in the intervertebral foramina. More rarely it forms circumscribed tumours.

With regard to the form of the disease, it is most commonly the medullary. Its usual seat is the inferior dorsal, and the lumbar regions of the vertebral column.

b. *Tuberculosis* of the dura mater of the cord occurs in cases of tuberculous caries of the vertebræ, both in the form of an inflammation attended with tubercular exudation, and in that of tuberculous suppuration.

It is remarkable that no production of bone, such as occurs so commonly within the cranium, and is known in that situation as ossification of the dura mater, should ever be met with in the dura mater of the cord; or, at least, it is an extremely rare appearance. Its place is here occupied by the deposition of bone on the free inner layer of the spinal arachnoid.

OF THE SPINAL ARACHNOID MEMBRANE.

The spinal arachnoid, especially in its visceral layer, occupies a different position from that of the cerebral arachnoid, both physiologically and pathologically; for it forms a sac, which does not, as within the skull, adhere closely to the pia mater, but envelops the spinal cord without being fixed to it. Its position corresponds to that of the cerebral arachnoid, where the latter is stretched across, like a bridge, from one part of the brain to the other. The sac of the spinal arachnoid, therefore, is not single and external only as in the brain, there being also a second space, internal, and enclosed by the visceral layer of the membrane. Generally, however, by the spinal arachnoid sac the inner space is understood. And it is also that which, for its pathological importance, claims, beyond comparison, the most attention; the visceral layer, and the sac within it, being the seat of the most serious diseases of both the inner membranes of the cord, as well as of the products which those diseases furnish.

§ 1. *Anomalies in the Extent or Dimensions of the Membrane.*

—Besides the uniform enlargements to which the (inner) arachnoid sac is subject from exudations and dropsical effusion into it at various periods of both intra- and extra-uterine life, further anomalies are met with, belonging to the same class;—congenital partial dilatations, which, when combined with local (partial) fission of the vertebral column, represent the disease named *Spina bifida*. The arachnoid protrudes through an opening in the arches of the vertebræ,—generally an opening left in the mesial line by the deficiency of some lumbar or sacral spinous processes,—and forms a sac or diverticulum, which is filled with serum, and the cavity of which communicates through the neck of the sac with the chamber that contains the

cerebro-spinal fluid. The dura mater of the cord, extremely attenuated, is spread over it; but more commonly the arachnoid protrudes through a round or elongated opening in the dura mater also, and is then covered immediately by the general integuments. The sac varies in size, from a scarcely perceptible dilatation to the bulk of a duck's or goose's egg, or it may even be larger. The fulness of the sac, and its consequent tension and fluctuation, are much diminished after death, when it is more or less collapsed. Its base is always constricted, even when broad; and it sometimes forms a pedicle. The sac is composed of arachnoid membrane, and of general integuments, which are more or less attenuated in proportion to its size, and marked with scars, when it has previously burst. The canal by which its cavity communicates with the internal arachnoid space is short, and always narrow when compared with the area of the protruded sac, and it corresponds with the aperture in the posterior wall of the spinal column, and in the dura mater.

The spinal cord itself may be fissured; more or less of it may be wanting; or it may be quite natural. The nerves may present no further anomaly than that of being stretched longitudinally, but they usually separate from the spinal cord, and, gradually becoming thinner, and wasting, they terminate in the arachnoid, at the base of the sac. This is very commonly the case in somewhat large sacs in the lumbar and sacral regions, in which the dilatation of the arachnoid cavity is aided by a further and important agent in the separation of the nerves, viz., the receding of the spinal cord upward in the later period of foetal life.

The direct consequences of this vary with the circumstances of the case; there may be slight (Paresen), or complete palsies, which are generally combined with tonic cramp and contraction (club-foot, &c.); or there may be insufficient nutrition. When the tumour is compressed, general convulsions come on, and if the pressure be increased, coma ensues. The general integuments are sometimes so stretched that they inflame and slough, and, in this condition, they rend wide open. The latter accident sometimes occurs during birth, and the sudden evacuation of the contents of the sac is frequently rapidly fatal.

When the nerves and spinal cord are not involved in the disease, it is capable of cure, like the dropsical sacs of the

cerebral arachnoid, by being gradually emptied, or by ligature. It may be cured spontaneously by a single, or by repeated opening of the sac, and even by spontaneous separation of the sac, and obliteration of its neck within the fissure in the vertebræ.

In a few cases spina bifida continues to exist up to the period of puberty, and even beyond it: it then not unfrequently increases in size.

It is very commonly, if not always, combined with hydrocephalus, and thereby with hydrencephalocele, and hemicephalus.

The origin of spina bifida is traceable to the same cause which gives rise to dropsical sacs of the cranial arachnoid. A congenital dropsy of the arachnoid sac sometimes occurs, which is closely allied to spina bifida, and in which, whilst the sac is uniformly dilated, the vertebral canal maintains its integrity.

§ 2. *Diseases of its Texture.*

1. *Hyperæmia. Apoplexy. Inflammation (arachnitis spinalis).*—No congestion of the spinal arachnoid occurs, or inflammation of it to any extent, without a similar condition of the pia mater of the cord: and, as the vascularity is much more marked on the latter membrane, the description of these affections and of their products may be postponed till the diseases of the pia mater are taken into consideration.

There is, however, one condition,—a consequence of habitual, long-continued, or repeated congestions, and of slight attacks of inflammation, which, as it is an affection of the arachnoid membrane almost alone, demands notice in this place. It consists of dullness, opacity, and thickening of the arachnoid, and is usually combined with chronic effusions of serum into its sac (mostly the inner sac). These changes are sometimes diffused uniformly over a certain portion of the membrane; at other times they are developed at separate spots, and form insulated patches (plaques): but very slight indications, if any, ever occur of a granular thickening, corresponding to the pacchionian bodies observed in the cerebral arachnoid. The lumbar portion of the membrane is the most affected; and there, indeed, habitual congestions most frequently occur. The so-called ossification of the spinal arachnoid has some connection with these congestions.

Adhesions between the visceral layer and the dura mater

rarely take place, except as the result of local, and especially of traumatic, inflammations of the arachnoid.

2. *Adventitious growths*.—All forms of growth are very rare in this membrane; except *bone*, which forms a marked exception to the rule.

It is always found on the visceral layer of the membrane, and forms scales and plates, which are generally of small size; ranging between that of poppy-seed and that of a lentil, and but rarely equalling a pea or a silver threepenny-piece (*Groschen*). They are cartilaginous, or cartilaginous and bony, flexible, and of a white, or yellowish-white, colour. They are bent towards the periphery of the cylinder, and appear convexo-concave; and the larger they are, the more distinct is this peculiar form. They are imbedded in the arachnoid, but they project from the membrane inward rather than outward; their inner surface is rough, the outer smooth. Their number is very various; sometimes at one, or a few scarcely perceptible points only, the commencement of the bony growth, can be detected; in other cases they are very numerous. Their usual situation is the lumbar and lower dorsal regions; but, in a few instances, when they are very numerous, they may extend as high as the upper dorsal region.

Ollivier speaks also of *cancerous* tumours almost free in the arachnoid sac.

§ 3. *Anomalous Contents of the Spinal Arachnoid*.—As these are principally products of the vascular system of the pia mater, I shall treat of them among the diseases of that membrane. For the same reason, the morbid effusions are almost all confined to the inner arachnoid sac.

OF THE PIA MATER OF THE SPINAL CORD.

§ 1. *Diseases of Texture*.

1. *Congestion, apoplexy*.—The anatomical characters of this congestion are too evident to require description. The subjects of it are mostly those in the tenderest childhood; infants just born or suckling, and individuals in the years of growth. In the former, the congestion generally involves the pia mater of the whole spinal cord, and that of the brain also: in the

latter, on the contrary, it is generally habitual, and confined to the lumbar region of the cord, and is combined with distension of the sinuses in the vertebral canal, and with congestion—so-called hemorrhoidal congestion—of all the pelvic organs.

When the congestion is excessive, it becomes fatal as vascular apoplexy; but sometimes that termination is anticipated by the occurrence of hemorrhage into the sac of the arachnoid (apoplexia gravis). A quantity of blood, most of it loosely clotted, is then found filling the sac, sometimes even up to the medulla oblongata. This is observed especially in the individuals first named.

Amongst the results of spinal congestion, acute and chronic effusions of serum into the arachnoid sac may be noticed. The former, the acute, constitute serous spinal apoplexy, which also occurs mostly in children. The serum is generally of a yellowish colour, or yellowish tinged with red, and after it is effused, the vessels still remain overfilled. The chronic effusions consist of colourless clear serum. Opacity, thickening, or ossification of the arachnoid coexist with them, and dilatation of the sac in the lumbar region: congestion is not necessarily present with the chronic effusion, though there is abundant evidence in the dilatation and varicose state of the vessels of the pia mater, and in the condition of the arachnoid before mentioned, of its previous repeated occurrence.

The chronic effusions so common in advanced age, are, in part at least, consequences of the congestions brought on by atrophy of the medulla and nerves.

2. *Inflammation (meningitis spinalis).*—Inflammation of the pia mater of the spinal cord succeeds various internal injuries; and it may pass over to the membrane from adjoining inflamed tissues: but, besides being thus set up, it sometimes, though very rarely in comparison with cerebral meningitis, comes on spontaneously. It is very often combined with cerebral meningitis, and occupies the whole spinal cord; and it is a disease particularly frequent in early childhood (Billard). The characters of the inflammation are the same as those of cerebral meningitis, but there are several peculiarities about the exudation.

The greatest part, and even the whole, of the product of the

inflammation may be poured out upon the surface mater, into the inner sac of the arachnoid: one layer hangs loosely on the cord, enveloping especially part; while another, and still larger portion, mixed or less serum, is accumulated in the arachnoid sac behind the medulla. The pia mater is rendered slippery and is swollen by the serous portion of the exudate; its tissue contains very little plastic product, and but rarely. The cord generally appears pale and occasionally its texture is somewhat loosened and symptomatic œdema (serous infiltration). The existence of these appearances is found, on the one hand, in relation which I remarked at the commencement, between the spinal arachnoid and pia mater; and, on the other, in the density of the structure of the pia mater, and the closeness with which it adheres to the medulla.

The exudation is usually of a pure yellow, or of a yellow colour, coagulable, fibrinous, or purulent. I had occasion to suspect it to be of tuberculous origin; this observation accords with the facts, that spinal meningitis so commonly coexists with tubercular cerebral meningitis which produces similar exudate; that tubercle of every kind is extremely rare in the substance of the cord. An acute tuberculosis, indeed, so far as I know never takes place in it.

3. *Adventitious growths.*—They are all, as I have said, about tubercle, extremely rare. Ollivier mentions an encephaloid, which formed a layer, adhering to the inner part of the pia mater, from one end of the cord to the other.

SECTION II.—OF THE SPINAL CORD.

§ 1. *Deficiency and Excess of Development.*—A total want of the spinal cord, such as occurs when both the head and the tail are wanting, is rarely met with: but a partial deficiency is more frequently observed. In cases of acephalus the deficiency is proportioned to the extent to which the neck, the thorax, or the abdomen, are wanting. Allied to this is another deficiency, in which parts of the cord are arrested in their development in bulk: thus, when the upper or lower

are wanting, or withered, there is no enlargement in the cervical and lumbar regions of the cord.

An original deficiency, whether complete or partial, may be distinguished from that which, being produced by the destruction of the foetal medulla, merely has the semblance of being original, in just the same manner as hemicephalus and acephalus are distinguished from each other (p. 368). Hydorrhachis is, I believe, as much known by the name of spina bifida, when it is a disease of the spinal cord, as when, in the form of foetal dropsy, it affects only the spinal arachnoid sac (p. 437),—provided only the vertebral column be fissured. And I believe it will be best to treat of that disease in this place, referring to what has been said at p. 225, for the condition of the vertebral column.

In its highest degree, the cord is altogether wanting, and the nerves terminate on the inner side of the arachnoid. The vertebral canal is then usually wide open posteriorly—fissured, that is, to a great extent; the spinal membranes, especially the dura mater and arachnoid, are intimately united with one another, and shreds of pia mater hang within the latter from the extremities of the nerves. The membranes, like the bony canal, are open posteriorly; and the general integuments, deficient to the same extent, adhere to them on both sides at the margin of the fissure. Not unfrequently a streak of hair extends along the margin of the skin from the head downward, and just overhangs the line of adhesion. The posterior surfaces of the bodies of the vertebra are thus laid bare, being covered merely by the spinal membranes.

Sometimes, as an exception to this arrangement, the membranes of the cord are not open, but form a closed bag filled with serum. In some very rare cases of this kind the vertebral column also is not fissured.

In a less advanced degree of the disease, rudiments of the cord remain, and especially its anterior columns, more or less complete.

In a still less degree, the spinal cord is fissured, and appears open behind; it is broad and flat. The membranes and the vertebral canal are in the condition mentioned above.

Allied to this is an extremely rare case, in which the canal of the spinal cord still remains, and is dilated in consequence of chronic dropsy within it.

The degrees just spoken of are measured by the amount of destruction of the cord, and by the arrest in its complete development, without reference to their local extent. Each degree may affect the whole length of the cord, or only portions of it; and the simultaneous fissure in the vertebral column may constitute accordingly either a total or a partial (local) spina bifida. The latter may exist at any portion of the spine, or at two different parts in the same subject; the spinal membranes are then either fissured in the manner above described, or they are merely distended, and form the well known membranous sacs in the spinal region described at page 437.

Every case of hydrorachis is, usually at least, combined with hydrocephalus; but when the whole spine, or its cervical region, is fissured, the kindred disease, hemicephalus, or else hydrencephalocele, is always present too.

Hydrorachis is similar in its nature to congenital hydrocephalus; and when it reaches advanced degrees, it produces spina bifida, just as hydrocephalus occasions hemicephalus and hydrencephalocele.

The consequences of hydrorachis, are self-evident, when reference is made to what has been already said on the subject of dropsical arachnoid sacs.

Spina bifida in its slightest degree is occasioned by dropsy of the arachnoid sac; the cord maintains its integrity, but the development and closure of the arches of the vertebræ are arrested, and the arachnoid bulges through the apertures in the posterior wall of the vertebral canal: it is generally only partially dilated, and forms a sac, such as has been already described (p. 437). The chief situation of this form of spina bifida is the lumbar, lower dorsal, and sacral regions.

In a few cases the cord itself passes through the fissure in the vertebræ, and a hernia of the spinal cord takes place.

Excessive development of the spinal marrow is met with only in double monsters. Its form varies according to the extent of duplication, &c.

§ 2. *Anomalies in Size.*—The length of the spinal cord generally has some relation to that of the vertebral column: so it, for instance, in individuals in whom a tail exists, the cord

is unusually long. But sometimes there is more or less of disproportion between the two: the cord is unusually short; or being unusually long, it suggests the recollection of its condition in the fœtus. Thus, for example, in fission of the vertebræ (*spina bifida*) it is in part of really unnatural length, and partly it has the appearance of being too long, because the vertebræ are arrested in their development, and frequently at the same time malformed.

The thickness of the spinal cord is subject to many peculiarities in different individuals, as well as to various local anomalies, which affect particularly its enlarged portions, and depend on deficient or excessive development at the periphery of the nervous system.

Considerable morbid enlargements in the bulk or diameter of the cord result from various anomalies. Some of the enlargements are local, and are bounded by a more or less sharp margin; while others, on the contrary, extend throughout the whole cord. The principal are congestion, apoplexy, œdema, inflammation, serous effusions into a persistent fœtal canal, similar effusions which fill up the space when the gray tract is atrophied, morbid growths, and so on, and lastly hypertrophy. The last is the only one which properly belongs to the present section.

Hypertrophy of the spinal marrow is exceedingly rare when compared with that of the brain. Although some of the many cases which have been adduced as hypertrophy are certainly of a different nature, and others appear to be at least doubtful, yet there can be no doubt that such a disease really does occur. It affects in some instances the whole cord, and is then almost always combined with hypertrophy of the brain, which forms the more prominent feature in the case: in other instances it is partial, and especially affects the enlargements of the cord; or at least they appear to be its original seat, and from them the disease extends to the other parts of the cord.

Ollivier holds the swelling which the marrow presents near a part that has been subject to pressure, especially above such a part, to be hypertrophy. If this swelling be not produced by some distension of the medullary tubes, by an enlargement resulting from the displacement of their contents out of the compressed part, yet it may resemble the secondary form of hypertrophy of the brain, that, for example, which arises

from the irritation of growths in the brain; or perhaps, more commonly still, it may be a condition in which congestive swelling, œdema, and hypertrophy all meet together. It reminds us of the hypertrophy which the brain undergoes when the medulla oblongata is subjected to pressure (p. 376).

The character of the spinal marrow, when hypertrophied, is, on the whole, analogous to that of the hypertrophied brain: its form becomes round and plump, and its grooves seem smoothed out; it has a peculiar turgescence, while at the same time the cord and pia mater are anæmic; its consistence appears to be firm, but when the membranes are removed and the cord itself is pulled asunder, it is found to have the consistence of dough.

It occurs mostly in children, and sometimes even in the fœtus. Ollivier has noticed it in several cases affecting the gray substance.

A more frequent and a better-marked affection of the cord is atrophy, and a diminution of volume to which it gives rise. Atrophy occupies either the whole cord, or merely separate portions of it. Most frequently total atrophy is but partial at first, and gradually extends till it occupies the whole length of the cord.

Total atrophy of the spinal marrow comes on in old age simultaneously with the same affection of the brain (*atrophia medullæ senilis*). Though it is equally a primary disease in the medulla as in the brain, yet it is usually better marked in the latter organ. Its characteristics are identical with those of senile atrophy of the brain, diminution of volume, and dirty whiteness of the fibrous columns, a rusty-brownish, fawn tint of the gray substance, and toughness of the white substance, even to a degree like that of leather. Chronic effusions of serum in the sac of the arachnoid accompany it, and opacity, thickening, and ossification of that membrane. Not unfrequently the cord, discoloured as before mentioned, is infiltrated with serum, and its substance is then soft and withered. Like the corresponding atrophy of the brain, it may come on as a premature marasmus.

The partial atrophies are, most probably, in many cases consecutive upon disease at the periphery of the nervous system. They affect particularly the enlargements of the cord. Atrophy of the lumbar portion especially, under the name of *Tabs loralis*, has long obtained the attention of physicians, as a

consequence of decay of the generative powers, and spermatorrhœa. From thence the wasting gradually extends, as has been said, and becomes a total atrophy.

These atrophies attain various degrees, which are determined simply by the diminution in the volume of the cord. They vary so much, that in one case the wasting is but just discernible, while, in another, the cord may have but half, or scarcely half, its natural thickness. There are differences, also, in other respects: thus the white columns vary in their consistence, sometimes being natural, but more frequently compact, dry, and even as tough as leather.

In some few cases of considerable wasting, the cord is found constricted here and there, and nodose, a series of bulgings being produced by successive constrictions of the cord.

From numerous observations I may assert, generally, that the more advanced degrees of atrophy, such even as are palpable at once, and not those which are discernible only upon comparison with other preparations, are rare.¹

The secondary atrophy which the cord undergoes, in consequence of diseases of its texture, especially of inflammation, will be described below.

Lastly, when the cord is subjected, in any part, to the pressure of enlarged, or of dislocated (inflamed and carious) vertebræ, of exostoses, aneurisms, morbid growths, &c. it becomes flattened and thin, in proportion to the amount of pressure. In such cases it is found swollen and thickened, especially above the compressed spot, and, very commonly, below it also. This condition, as I have before remarked, is distinctly asserted by Ollivier to be one of Hypertrophy.

§ 3. *Interruptions of Continuity.*—Various instruments penetrate to the cord, and inflict upon it incised, punctured, or shot-wounds. Much more frequently it is contused and lacerated by fractured, crushed, comminuted, or dislocated vertebræ: but sometimes these injuries are occasioned merely by excessive stretching and concussion of the spinal column. The most remarkable and important of the injuries which the cord undergoes in consequence of luxation of the vertebræ, is that in

¹ [The construction of this sentence seems to indicate that a word has been omitted, and that the author would say, such degrees of atrophy are *not* rare.—Ed.]

which sudden death ensues, immediately upon its being crushed or lacerated; such an event occurs when those bones are dislocated spontaneously, and especially when, in consequence of inflammation and suppuration of the ligamentous apparatus, and of caries, the odontoid process of the second cervical vertebra becomes loose, tears through the dura mater, and is dislocated into the vertebral canal.

Sometimes only a part of the cord is bruised: at other times it is changed in its whole thickness, and more or less of its length, into a suffused red pulp; or it is crushed quite through. In the last case, the two ends of the cord are held together by the pia mater; but if that also be torn, they remain opposite to each other, and quite free. The inflammation and yellow softening of the cord, which result from injuries of this kind, usually carry them on to a fatal termination; but sometimes it is by the paralysis and its consequences that life is destroyed.

§ 4. *Diseases of Texture.*—*Congestion, Apoplexy.*—Congestion of the spinal cord is a symptom in the course, and a sequel, of sundry acute and chronic diseases. Such, most probably, is its real import, in those who have died of tetanus, convulsions, and hydrophobia. It is almost constantly met with in those cases, combined with an equal degree of congestion of the brain. In other cases, it is set up by inflammatory processes in the vertebræ, by the pressure and irritation of exostoses and swollen or luxated vertebræ, and by morbid growths in the cord itself: and it leads to permanent turgescence and hypertrophy of the medulla.

But it also comes on idiopathically. It then usually pervades the whole cord and its membranes, as well as the brain, and is most frequently met with in early childhood: in adults it is confined to the lumbar portion of the cord (Compare p. 440).

I have had occasion to attribute several affections to what is called spinal irritation; and subsequent communication with the physicians who had had the treatment of the cases, has proved that I have done so correctly. Sometimes there existed a certain amount of congestion, but very often there was neither congestion nor any other unnatural appearance.

Spinal apoplexy, that is to say, hemorrhage independent of injury, is one of the rarest appearances. When it does

occur, it is at the cervical portion of the cord, and almost always in the gray substance.

2. *Edema*.—In both its acute and chronic form œdema frequently affects the cord, infiltrating, loosening, and producing what is called "white softening" of its texture. What has been said in general of œdema of the brain, applies also to that of the cord. When it extends over the whole cord, the brain is usually in the same condition.

3. *Inflammation*.—All that has been said of inflammation and red softening of the brain, applies in every respect to inflammation of the spinal cord: only the latter is in comparison much less frequent. In the cord, as in the brain, inflammation attacks sometimes the white tracts, sometimes the gray substance, sometimes both together. But it is a striking fact, and worthy of especial notice, that inflammation of the gray substance affects that part in long streaks, or in its whole extent, restricting itself to that substance, and producing a peculiar condition of the cord as well by the increase of volume which attends its softening, as by a peculiar form of dropsy in which it occasionally terminates. The red softening of the gray substance which accompanies it, and which is tinted according to circumstances, of a chocolate brown, or a plum sauce colour, rusty brown, or yeast-yellow, corresponds with the *central softening of the spinal cord*, described by Albers.

The following three cases will be found to represent the characteristics of this process; the preparations taken from them are in the Vienna Museum.

CASE I.—P. Joseph, æt. 23, a journeyman joiner, was admitted into the General Hospital, January 19, 1835. He stated that three weeks before admission, he had stood a considerable time in cold water, and had in consequence experienced violent acute pain in the feet and back, accompanied with fever. A few days afterward, tremulous motions and loss of sensation came on in the lower extremities. On his admission he was unable to stand, though he could move his feet in bed; and he had difficulty in passing his urine: he had no fever. In another fortnight the power of moving the legs was quite lost, the urine accumulated in the bladder, and produced a burning pain as it was passed: the vesical region became painful: fever super-

vened, and frequent vomiting. In March a slough formed on the sacrum, bloody urine was passed through the catheter, and on the 29th of the same month, the patient died.

Examination of the body.—There was a large slough on the sacrum. The penis and scrotum were swollen, and on the latter were several dirty brownish sloughs.

The lungs generally were œdematous, and their upper lobes tuberculous. The kidneys were large, their pelves were somewhat dilated, the urinary bladder was moderately distended, and its mucous membrane was covered with an exudation which was a line in thickness; whilst underneath it was of a blood-red colour, injected, and here and there changed into a brown slough. The cellular tissue of the scrotum was filled with a brownish fetid ichorous fluid.

Spinal cord.—There was a small quantity of serum in the arachnoid sac. The spinal cord was swollen in the lower part of the neck, and still more so in the upper dorsal region; in the latter part its gray substance was infiltrated with a grayish yellow exudation, and was itself in a state of red and yellow softening (*gelbröthlich erweicht*). About the second and third dorsal vertebræ, the place of the gray matter was occupied by a firmly fixed cylindrical plug of yellow exudation, more than an inch in length, and from three to four lines in thickness.

CASE II.—St. Leopold, æt. 22, after a fall on his head, three years ago, had been suffering from pain which was at first slight and transient, and confined to the occiput, but subsequently became severe and continued, and affected the whole head; it at last extended to the nape of the neck, and the upper extremities.

In the second year of the disease, after a feverish attack, which lasted fourteen days, his spinal column began to bend, and he became subject to continued vertigo. All the symptoms diminished while he was in the recumbent posture, and increased after taking a meal: the latter, moreover, was always followed by ineffectual efforts at vomiting. On his admission into the hospital, he had, on the whole, a florid appearance: the symptoms above mentioned were all present; the countenance was ruddy; the head hot; the pulse was accelerated;

the respiration natural; and the bowels at times were sluggish. During two months in which treatment was employed, the symptoms at times abated, and then grew worse again. In the latter part of his life, erysipelas came on in the face: for the last two days he had pain in the bowels; and some hours before his death, he lost consciousness, and had paralysis of the lower extremities.

Examination of the body.—The body was pretty well nourished. The pia mater was infiltrated, and the surface of the brain pale: its white substance was also pale, it was moderately vascular and soft, and contained serum. The vessels at the base of the brain, especially about the pons, were dilated and tortuous.

The lungs were of a dark red colour, and congested; the upper lobe of the left was œdematous.

In the peritoneum there was a pound of serum mixed with flakes of lymph. Numerous hemorrhagic erosions, as large as pins' heads, dotted the mucous membrane of the stomach. The liver was shrunken, and of a deep yellow colour; a few drops of dirty grayish-yellow bile were found in the gall bladder. The follicles of the small intestines were swollen. The colon contained grayish clay-like fæces. The kidneys were flabby and vascular: the urinary bladder was contracted, and contained half an ounce of turbid urine.

The vertebral column curved in its upper dorsal region backward, and to the right. The vertebral venous sinuses were very full of blood; the dura mater was relaxed; the arachnoid was opaque, and in the lumbar region contained several small plates of bone. The spinal cord was swollen, and felt soft and fluctuating. The white columns were distended into a kind of bag, and enclosed instead of cineritious substance, a grayish briny fluid infiltrated through a loose delicate cellular structure. The change extended upward nearly to the medulla oblongata, and downward beyond the lumbar enlargement of the cord.

CASE III. L. Katharina, æt. 40, eighteen years before death, had a fall from the top floor of a house, by which the spinal column was fractured in the lower dorsal region. The injury got

well with an angular curvature in the back, but left behind it an unsteady, dragging gait, and incontinence of urine. While she was in the hospital, the most marked symptoms were redness of the general integuments, and pain on moving. She died with fever and diarrhœa, extremely emaciated.

Examination of the body.—Much emaciation. The left lower extremity was œdematous. The vertebral column was bent at an obtuse angle in the lower dorsal region, and above that point was slightly curved in the form of the letter S.

There were cellular adhesions of both lungs, and partial œdema, and lobular hepatization of the right lung posteriorly. In the right upper lobe there was an abscess as large as a hen's egg, and a second as large as a hazel-nut, close to the pleura.

(The gall-bladder was distended with a fluid, like white of egg; and its neck was obstructed by a crystalline stone as large as a dove's egg. The mucous membrane of the large intestines was strown with stalked granulations.)

The kidneys were large. The urinary bladder was contracted and empty; and spots of its mucous membrane were softened, dark-red, and injected. The right ovary was converted into a sac of fat larger than a hen's egg.

The substance of the brain was pale and tough.

The dura mater at the base of the skull, especially at its basilar part, and in the neighbourhood of the sella turcica, was of a dark red colour, and covered, especially in the former situation, with a yellowish exudation. The cavernous sinuses, the circular sinus, the anterior occipital, and the commencement of the petrous sinuses were filled partly with a brown friable coagulum of blood, but for the most part with a brown and yellow purulent fluid. The left crural vein, and its branches down to the leg, contained a brown coagulum, the outer layers of which were softening, and becoming purulent; whilst within the pelvis it was filled with a brown ichor-like fluid. The commencements of the hypogastric veins, and the iliac, up to the cava, were filled with a similar fluid. The coats of the veins were thickened and discoloured, the inner coat being loose like nap, and dull.

At the part where the column was curved, the canal through the vertebræ was contracted to a narrow fissure. A good deal

of serum was accumulated in the sac of the spinal arachnoid, and, in the lumbar region, that membrane was occupied by small osseous plates, of about the size of lentils. The pia mater was traversed by distended vessels, and, in the lumbar region, infiltrated with a briny fluid. The spinal cord, from the dorsal curvature to the second cervical vertebra, was converted into a fluctuating bag, which was composed of the white columns, and contained a clear serous fluid, but no gray substance, that having disappeared. The columns were softened and pale; the posterior middle columns were forced asunder more than half a line. The inner wall of the bladder was lined by a delicate cellulo-serous tissue, which projected inward, forming numerous ledges, and also extended in bands across the canal from one wall to the other.

Viewing these cases in order, we observe in the first a very intense inflammatory process (red softening) in the gray matter of the cord, distinguished for the quantity, and plastic nature of its products; the gray matter was augmented in bulk, whilst the white columns around were distended. In the second case, the absorption of one part of the products had commenced, and of the substratum, in which the process was going on, while another part of the products was in course of conversion into a cellular structure, and was infiltrated with serum. In the third we find the issue of the process: in the place of gray substance there remained a cavity lined by a part of the products of the inflammatory process organised to a tissue, and constituting the cellular infiltration of Durand-Fardel. (p. 411.) We have here a dropsy of the spinal marrow, quite peculiar, both as to its cause, and as to its nature: the cases in which it has occurred have been recently collected and arranged by Nonat.

In consequence of inflammation (softening) involving the whole thickness of the medulla, the cord has been found completely divided.

4. *Softening and induration.*—The same forms of softening which happen in the brain, are found to occur in the spinal marrow also. But, on the whole, they are more rare in the latter. *White* softening very seldom reaches that degree of complete destruction of the nervous tissue, which is so frequently met with in the brain, especially in the neighbourhood

of the ventricles. *Red* softening (myelitis) assumes the very remarkable form which I have just described as central softening of the cord. *Yellow* softening may, without doubt, occur in the cord as a primary and idiopathic disease; but my own observation has furnished me with instances of its secondary form only, in and around spots of inflammation, and encompassing morbid growths.

Induration of the cord, though comparatively rare, yet does occur in all the forms, and with all the import which were asserted of it in the brain. Indurations of slight degree are the sequels of general diseases, and are unaccompanied by any manifest further anomaly. More considerable indurations are combined with atrophy. And, lastly, condensations and callosities of parts of the cord, are met with as consequences of inflammation, apoplexy, and morbid growths. They are seated mostly in the white columns.

5. *Morbid growths*.—Growths of this nature, even those which, like tubercle and cancer, are frequent in the brain, are very unfrequent in the spinal cord.

a. *Tubercle* I have observed only in combination with other advanced tuberculoses. Its principal seat is the cervical or lumbar part of the cord, where it sometimes occupies the white fibres, sometimes the gray substance. As in the brain, it leads to inflammation (red softening) and to yellow softening. I have never seen a tuberculous cavity in the cord. Sometimes several tubercles are grouped together, none exceeding the size of millet- or hemp-seed; at other times only one exists, which is of large dimensions, equalling a pea or a bean.

b. Exclusively of several cases of circumscribed callous induration of the white columns, as to the cancerous nature of which I am still in doubt, I have met with but one case of *cancer* of the cord. It was a solitary nodule of medullary cancer. Ollivier mentions several examples of diffused carcinomatous growths, as well as of so-called colloid cancer.

c. Among the entozoa, I have repeatedly seen the *cysticercus* in the cervical portion of the spinal marrow. The *acephalocyst* sacs, so far as has been observed, have no connection with the cord, their nidus is even outside the dura mater. In one case the cyst forced its way into the canal of the arachnoid.

CHAPTER III.

ANOMALIES AND DISEASES OF THE NERVES.

I venture to treat of all of these under one head, introducing the affections of the ganglia at the end of each chapter, somewhat in the form of an Appendix. To subdivide diseases of the nerves into such as affect the neurilemma, and such as involve the fibres, in the same manner as the affections of the central organs were divided into those of the organs themselves, and those of its membranous investments, is for the most part impossible: for, on the one hand, those elements are in the nerves too intimately united, and on the other, our information on the subject is too defective to permit such a distinction. And not only is it impossible, but if the necessary attention were paid to the subject, the distinction would prove of no real value.

§ 1. *Deficiency and Excess of Development.*—The nerves seem never to be altogether wanting, even in those monsters which are most imperfect; but a single one, or even several, are not unfrequently so. Not only are no nerves developed when the parts which they should supply do not exist, but they are defective, though not perhaps quite absent, when portions of the body are incompletely formed; as when there are limbs, but no muscles within them. The most frequent instances of deficiency are those of the olfactory and optic nerves, when the nose, the eyes, or the whole face are wanting, or arrested in their development. Usually, when no eyes have been formed, or when their development has been arrested, the third, fourth, and sixth pairs, and the first branch of the fifth are deficient too. In a cyclops in which the face was almost entirely wanting, no facial nerve could be found; nor can even the lingual branch of the fifth pair, or the hypoglossal, when no tongue is developed. (Tiedemann.) “In monsters born without extremities, or with only imperfect ones, the deficiency of the limbs corresponds exactly with that of the nerves; for when single fingers or toes, a

hand or foot, a forearm or leg are wanting, their nerves are wanting too; if there be a deficiency to the extent of a whole limb, the brachial or the lumbo-sacral plexus is small, appears entangled, and gives no branches except to the neighbouring part of the trunk. If, with the arm, the shoulder should be absent, or half the pelvis with the lower extremity, their nervous plexuses are absent also, and only some posterior branches for the muscles of the neck, or for the lower part of the dorsal muscles, pass out through the inter-vertebral foramina. In those monsters, not unfrequently found in the human species, which are without the radius and thumb, the radial nerve ends at the elbow, or merely sends down a few slender threads to the back of the hand." (Otto.)

Lastly, there are frequently no nerves in supernumerary parts, especially such as are imperfectly formed.

The absence of a nerve is often only apparent; when the periphery is examined, as it always should be to determine the deficiency absolutely, the nerve will sometimes be found running in one sheath with some other nerve. A nerve sometimes appears to be wanting, when it is only partially so, the trunk of the nerve not reaching the central organ.

Excess of development is illustrated in a plurality of the nerves. An unusual division of a nervous trunk into its branches, or a division of it in an unusually high position, presents merely the appearance of plurality. A real plurality occurs only when there is an increase in the number of other corresponding parts of the body; for instance, there is one spinal nerve more when there is an additional vertebra, and more digital nerves when there is a perfectly organised supernumerary finger. In double monsters, the nerves are doubled and divided according to the manner and degree of the duplication; or they are double, but communicate in parts of their course; or they are originally double, then unite, and remain single.

As it has been noticed that the absence of nerves is often only apparent, so may it also be observed that an excess of development is sometimes only apparent too. Sometimes the unusual branching of a nervous trunk gives it the appearance of being developed to an unnatural degree.

Deficiency and excess in the development of the ganglia are exemplified, on the one hand, in their absence or unusual

smallness; and, on the other hand, in their presence on nerves where they are not generally found, or in their existence in unusual number or size.

§ 2. *Malformations; and anomalies in the origin, course, and branching of nerves.*—Anomalies in the form of the trunk of a nerve are very seldom of any importance; instances of it are met with in the olfactory nerves, which are sometimes hollow at birth; and in the optic, which are found in cyclops monsters to be single, or in various extent fused together.

Malformations of the brain occasion many variations in the origin and course of the nerves, even in individuals who are otherwise naturally formed. The best examples of this are afforded, in cyclopia, by the optic and four following nerves of the eye; by the third nerve when it gives off the long root of the ophthalmic ganglion, and by the sixth, which may supply a nasal branch that is lacking from the fifth. (Otto.)

Next to these may be arranged anomalies in the branching of nerves, and in the formation of anastomoses and plexuses, unusually high divisions, splitting of a nervous trunk in the form of islands, deficient, multiplied, uncommon anastomoses, &c.

§ 3. *Anomalies in Size.*—These anomalies relate to the thickness of the nervous cords. A palpable increase of all the nerves beyond their natural bulk is extremely rare; a few instances of it only having been observed in idiots, either affecting all the nerves uniformly, or predominating in the sympathetic system. It is more frequently met with in a single nervous trunk.

It has various causes, but the most common are inflammation, inflammatory products, and morbid growths. A more important question is that relating to the increase in size which nerves acquire by hypertrophy.

There is no proof that hypertrophy of a nerve consists in the formation of new fibres in addition to those of which it was originally composed, and the present state of our knowledge opposes any such explanation. It might be, indeed, that the nerve-tubes become enlarged by an increase of their contents; but this, also, is a mere hypothesis, which, although in some degree supported by the enlargement of the

ules, which Hermann Nasse has observed at the proximal end of a divided nerve before it is completely restored, can yet serve as practical proof of its existence, even from a future generation. Most probably the neurilemma of the nerve is the part which is hypertrophied. Such we must, for the present, consider to be the state of the enlarged nerves of hypertrophied organs, those, for instance, of a hypertrophied heart.

There might, however, be a true hypertrophy of the ganglia, an aggregating of new ganglion cells; although of it also we lack proof from facts. I have met with a case of general emaciation, combined with an eminent degree of hypochondriasis, in which the central abdominal ganglia were considerably enlarged.

It is a peculiarity frequent in individual conformation, that the nerves are more or less manifestly thin and slender. Very commonly, when the brain is hypertrophied, there is a striking thinness of the cerebral nerves. The nerves, too, of parts which are developed but imperfectly, or not at all, are thin from the first: an instance of this is met with in the optic nerves in cases of microphthalmos.

The nature of atrophy is more distinct than that of hypertrophy. Sometimes it is confined to the nerve-tubes, sometimes it involves the neurilemma also. There are various conditions under which it occurs.

1. It is only when general emaciation has advanced to an extreme degree that genuine atrophy of the nerves can be shown to exist with it. In ordinary cases the diminution in their size may be referable to the loss of their natural moisture, and, after that, to wasting of the neurilemma.

2. Pressure and stretching often produce atrophy of a nerve, even to such an extent as gradually to destroy it in its whole thickness. We see facts of this kind exerted upon nerves by morbid growths, aneurisms, and enlarged organs: especially we might instance the bronchial plexuses of the vagus nerve, which sometimes become so wasted from the presence of tuberculous bronchial glands, that their continuity is at last destroyed. The nerve is at first not unfrequently flattened, its fasciculi spread abroad, and at length it disappears altogether at the compressed spot. Above and below, it retains its natural thickness, though, probably, only for a certain time. This

form of atrophy evidently affects the whole nerve equally, the nerve-tubes being at first diminished and compressed, and in the end absorbed.

It can be understood that inflammatory products in the neurilemma of a nerve may press upon the tubes and interfere with their nutrition, and so lead to their becoming atrophied : thus, while a nerve is actually increasing in size, its essential element may be diminishing.

3. A nerve may be atrophied in consequence of the wasting and loss of the peripheral or central organ to which it belongs, in fact, in consequence of a permanent solution of its continuity. Frequent examples of such atrophy may be adduced. On the one hand, the optic nerve shrinks because the globe of the eye is wasted, and the nerves diminish in size after the removal of a peripheral part by amputation ; while, on the other hand, they are found to lessen in volume when their central organs have wasted ; and, again, they are in an atrophied condition in hemicephalus, hydrocephalus, &c., at least within the skull. In these instances it is unquestionably the nerve-tubes which are affected ; and all of them, or only a few are affected, according to the amount of wasting, or loss of substance at the periphery or the centre, which is the occasion of the atrophy. Under certain circumstances, nerves, which are extremely atrophied, acquire a translucent grayish-red appearance, especially within the skull. The colouring is produced by the presence of a blastema, filled with numerous nuclei, which, at first gelatinous, and afterwards tough and elastic, takes the place of the nerve-tubes as they disappear, and becomes more distinctly visible as the original neurilemma of the affected nerve diminishes. The vessels of a nerve in this condition are often palpably dilated.

4. We not unfrequently observe a withered state of the ganglia, a shrinking and leather-like toughness of them, while their colour has either altogether disappeared, or is changed to a rusty brownish, yeast-yellow, fawn, or slate gray. It appears frequently to be a primary affection ; but in many cases it is a secondary consequence of previous disease. The chief example of it is the wasting of the abdominal ganglia, which follows typhus, and forms one of the few causes which can be found by the knife of the anatomist, for the sickly state succeeding typhus (*Typhus-siechthum*.)

§ 4. *Solutions of Continuity*.—Nerves, just like other parts, are liable to incised and punctured wounds, to contusion, stretching, laceration, &c. A clean cut affords the best prognosis; especially when the ends of the nerve are secured against contact with the atmosphere, and pressure from excessive inflammatory tumefaction of other soft parts which may have been wounded at the same time; and when it is not irritated by foreign bodies, inflammatory products, &c. The process by which such wounds are healed and the nerve restored, have been studied both in man, and, by experiments, on animals. (J. Müller, and Sticker, Steinrück, Nasse, Günther, and Schön.)

After a nerve has been divided, its extremities retract a little, and some of the medulla is pressed out by the contractile neurilemmatous sheath. Inflammatory injection and reddening then ensue, with some swelling which fills out particularly the looser cellular sheath of the fasciculi. Hence the fasciculi which compose each nervous cord are forced asunder at the divided extremity; and when exudation takes place, their separation is still more marked. The exudation is poured as well into the tissue of the neurilemmatous sheaths of the nerve, as into the space between its two ends; and coagulating there, it forms a gelatinous, yellowish-red mass, which reunites the divided portions, and mixes with the exudation furnished by the adjoining tissues which have been wounded at the same time. In this exudation nuclei and cells then form, and the regeneration of the nerve takes place. After some time, fibrils are perceived in the exudation, which advance towards each other, from the nerve-tubes of the two extremities; they are most distinct near the end of the nerve, and are least developed in the middle of the exudation-callus. After a still longer time, complete nerve-tubes present themselves in the callus, which appear on the whole smaller than the original tubes (Nasse); but some years later, old and new tubes can be no longer distinguished from one another. A different portion of the exudation serves for the regeneration of the neurilemma; whilst yet another portion remains behind, an unorganised (*gestaltloses*) blastema, and produces a nodular swelling of the new-formed piece. This nodule is generally largest at the upper extremity of the nerve, and does not disappear for a very long period. An adhesion forms between it and the cicatrix of the neigh-

bouring tissue; and this, too, may be equally permanent, or it may be loosened by absorption.

From the complete restoration of the function of the nerve, at least in all its material relations, it may be inferred that, most remarkably, in most, if not all, instances the proper primary filaments reunite. Sometimes this is not the case, as may be seen by anomalies in their direction; filaments alike in kind are united, but not those which properly belong to each other. Dissimilar nerves and filaments, such as motor and sensitive, seem never to unite with one another, at least their doing so is very questionable. (Bidder.)

Of course, the difficulties in the way of this regenerative process are enhanced by any loss of the substance of the nerve.

If no regeneration take place, the primary filaments waste, especially those in its distal portion, and the whole nerve gradually acquires a grayish red or gray aspect. In the other extremity these changes are confined to a certain tract, and to particular primary filaments.

The ends of the nerves divided in amputations swell out, and for the most part unite together in one common hard knot, with which the cicatrix of the neighbouring soft parts also coalesces. If there be not soft parts enough to preserve the knot from pressure, or if the soft parts pull upon it, symptoms not unfrequently arise which may be so severe as to require that the nerves should be divided again.

Even the peripheral nervous bodies (ganglion-cells) appear to be capable of regeneration. (Valentin's Physiology.)

§ 5. *Diseases of the Texture of Nerves.*

1. *Congestion—apoplexy.*—It may be that nerves are not unfrequently congested; but there is scarcely ever opportunity in the dead subject to see any such condition of either their trunks or branches, except what has occurred since death.

More important instances of hyperæmia are found in the sympathetic system; its central ganglia become congested in the course of general acute processes of low type (dyscrasisch), which become localized in those structures to which the ganglionic nerves are distributed, especially in the mucous membrane and follicular apparatus of the intestines. The congestions of the

ganglia just mentioned in the early stages of ileo-typhus, in the course of cholera and cholera-typhus, are of this class.

These congestions sometimes lead to apoplexy. In that case, (during the same processes) the ganglia are found ecchymosed, or dotted with little round spots or streaks of extravasated blood, which are of about the size of millet-seed.

2. *Inflammation*.—Inflammation may be observed in nerves as a consequence of injury, especially after they have been cut through: and in the trunks of larger nerves, such as the sciatic, rheumatic inflammation is met with in the dead subject. Inflammation may also pass over to nerves from adjoining tissues.

Its general characters are those of inflammation of fibrous tissue, inasmuch as its seat is the neurilemmatous sheath. When it is very intense, the characters of the red softening of nervous tissue are added. Its course is sometimes acute, sometimes chronic.

The marks of *acute* inflammation are as follow:

a. *Injection*, which presents a linear arrangement; and redness, which proceeds partly from the injection, and partly from small extravasations by which the neurilemmatous tissue is streaked and dotted.

b. *Looseness, succulence, and swelling* of the nervous cord, which result from the infiltration of serum into the tissue of the neurilemma, and into the sheaths between the primitive filaments. The fasciculi diverge manifestly from one another, and the nerve appears unravelled; and when the actual exudation is effused, this character is still more marked. The nerve has lost its smooth white glistening appearance; and its neurilemma is opaque, and appears rough and wrinkled.

c. *Exudation*. This is generally a grayish or yellowish-red, gelatinous product, which sooner or later becomes firm. It is effused into the sheaths and tissue of the neurilemma, as well as between the primitive filaments themselves.

The intensity of these appearances varies widely. The redness may be a slight rosy tint arising from injection, or a deep saturated red colour; it may be composed of some injected varicose branches, or of confluent ecchymoses. The swelling also may be of any degree according to the quantity of the exudation. And further, the process may be merely confined to

the outer layers of neurilemma, or it may extend more or less deeply to the sheaths of the several fasciculi.

d. The cellular tissue around the nervous cord always shares in these changes ; it becomes injected, reddened, and infiltrated with a serous or sero-fibrinous brine-like fluid. The inflammation may even extend to the sheaths of neighbouring muscles, to the fascia, subcutaneous cellular tissue, and general integuments.

This degree of inflammation may terminate quickly or slowly by *resolution* ; or in *induration* of the nerve and a permanent abrogation of its function in whole or in part. The products of the process remain behind in the form either of a hardened blastema or of filamentous tissue ; the nerve continues thickened, and more or less misshapen, and forms a grayish cord, which is sometimes marked with black pigment, and crossed by varicose vessels ; the fasciculi coalesce, and the nerve itself adheres to the parts around. The nerve-filaments diminish in size and finally disappear, partly because of the pressure to which they are subjected by the exudation in which they are enveloped, especially as after a time it begins to contract ; and partly because their nutrition is interrupted ; for the vessels are obliterated by the inflammatory process, or are usurped by the exudation.

e. By higher degrees of inflammation and by a rapid and copious (tumultuous) exudation, the primitive filaments of the nerve are destroyed. They are found coloured, and in a state of red, or of grayish or yellowish-red softening, while the neurilemmatous sheaths have become easily lacerable. Such a condition may sometimes be seen in cases of spontaneous inflammation, but it is more common when the inflammation has succeeded injury. The exudation is generally purulent.

f. When this is the case, that is, when the exudation is *purulent*, the nerve appears highly discoloured, and is infiltrated with a purulent fluid mixed with blood ; its neurilemma is as fragile as tinder, and is losing its vitality, while the mass of the nerve is changed into a yellowish-red, brownish-red, or chocolate-coloured pulp. The cellular tissue around the nerve becomes infiltrated with yellow fibrinous exudation, and abscesses of various size are formed here and there in its course.

The next step in such an inflammation is an *ulcerative* destruc-

tion of the nerve. But should it stop short at this point, granulations appear, which become progressively changed into cicatrix tissue: just as is observed in the stump of a nerve after amputation.—It must, however, be remarked that the nerves resist, for a long time, the suppurative and sanious destruction which may be going on around them.

Chronic inflammation is characterised by the varicose state of the vessels of the affected nerve, by products which become indurated, and gradually increase in quantity, and by a change of the nerve to a slate or lead-gray colour. Sometimes the products are not deposited uniformly throughout the nerve, and then nodular swellings are formed on it.

There is one appearance which I must here mention as an appendix to the foregoing descriptions; it is the following condition of the nerves in cases of traumatic tetanus: and, however insignificant and unsatisfactory it may seem when brought into connection with the symptoms during life, yet it is the only real fact that has been made out in such cases after death. Froriep has ascertained that, besides the inflammation which is seen in the nerve at the spot which has been injured, a rosy reddening is produced at irregular intervals in its course by the injection of its neurilemma, but it is unaccompanied by any distinguishable products. The reddening is mostly confined to the surface of the nerve, though it sometimes dips a little way between the fasciculi. If a plantar nerve, for instance, has been injured, it is repeated three, four, five, or more times in the course of the tibial and sciatic nerves up to the sacral plexus; but neither where these nerves enter the medulla nor in the cord itself is any similar appearance to be found.

3. *Morbid growths in nerves.*

a. Cysts.—Even in the trunks of very large nerves such formations are extremely rare. It is at once clear from the conditions under which the cyst is developed that it performs the office of a bursa.

b. Fibroid tissue.—This structure is met with in nerves chiefly as a product of inflammation. But there are also certain tumours which are known generally by the name of neuroma, and which appear to me to rank with fibroid structures. When they exist in great number, as they sometimes do, pervading many, or most, or even all of the nerves, they constitute

that which Serres has most erroneously denominated a change of the nerves to ganglionic structure.

Neuroma is the most frequent adventitious growth, except cancer, which occurs in the peripheral nervous system; and cancer is very frequently only a secondary affection in which nervous tissue is involved in consequence of its contiguity to other diseased organs.

Neuroma forms round, or more usually elongated and oval, tumours, the long diameter of which is parallel to the nerve. They are of a tough elastic consistence, and of a grayish or pale yellowish-red colour, and are invested with a distinct fibrous sheath. In size they vary from a scarcely discernible enlargement of the nerve, to the bulk of a walnut or even of a hen's egg, and in number, from one until they are almost countless. In this last case neuroma constitutes a very remarkable general disease, as to the cause of which we are still in the dark. It has already been observed several times, and three times in the Vienna Hôpital. It has been noticed in such cases, that the size of the tumour bears no direct proportion to the thickness of the nerve on which it is formed, for in fact those tumours which are situated on small branches are relatively much larger than those which occupy the thick trunk of a nerve.

The tumours lie between the fasciculi of the nerve, and are interwoven with their neurilemmatous sheath. And it is a remarkable, and no less important general rule, because of the symptoms which may result from its presence, or which may be set up by operations performed on it, that neuroma is never deposited in the centre of a nerve, but at its side, so that only a small part of its fasciculi is displaced; the displaced fasciculi are spread abroad and stretched over the tumour, while the greater mass of the nerve remains on the other side uninjured, and with its fibres in connection with one another.

Neuroma occurs most frequently in the spinal nerves, and in those cerebral nerves, motor as well as sensitive, which resemble the nerves of the cord: it may occur at any point in their course, even within the canal of the dura mater of the cord, and close to their junction with the medulla.

Although neuroma, when a solitary tumour, frequently occasions very considerable annoyance and pain, yet such is by no

means invariably the case; and in those instances in which neuromatous growths were extensively diffused through the nervous system, they had given rise to no symptom whatever.

c. I have never met with any instance of anomalous bony substance, or so-called *ossification*, in nerves, although the callus remaining in them after inflammation, and neuromatous tumours, seem to furnish a suitable foundation for the production of it.

d. Nerves may be destroyed in the softening of *tubercle* either around or adjoining them, though the larger nerves resist tubercular and all other suppurative destruction for a long time. Nerves are never the seat of primary tubercle. With cancer, however, the case is different.

e. *Cancer* often occurs in the peripheral nervous system as a secondary disease, the nerve yielding to the aggression of a neighbouring cancerous growth: and not unfrequently it presents itself as a primary disease. In respect to the former, the secondary affection,—when any organ is the seat of cancerous degeneration, the nerves included in it may be destroyed in the same manner as other tissues; or a cancerous mass, as it advances, may involve any nervous trunk that lies upon it.

Whether the nerve be primarily or secondarily diseased, the form of the cancer is generally the medullary: indeed, the white medullary cancer and melanosis appear to be the only forms with which nerve is primarily affected. Although a nerve when secondarily affected with any kind of cancer, is attacked, as a general rule, in the same manner as any other tissue, yet it is remarkable how little resistance it appears to offer to the inroad of medullary cancer in particular.

Primary cancer may be developed at the peripheral extremity of a nerve, or at any other spot in its course, up to its termination in the nervous centre. The former is by far the most frequent situation, and the best known example of it is medullary cancer of the retina.

Medullary cancer of nerve, as that of the retina shows, commonly reaches a very large size. Very often it is quite alone in the system, though not unfrequently it is combined

with cancer in other organs. Thus cancer of the optic nerve within the skull, and of the brain, often coexists with cancer of the retina. The extirpation of *fungus bulbi*, or primary cancer of the retina, is, as a general rule, succeeded by a very rapid and extensive (tumultuous) development of cancer in several organs at once.

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